TETRA TECH, INC.

DRAFT HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT WORKPLAN FOR THE GEORGIA-PACIFIC CALIFORNIA WOOD PRODUCTS MANUFACTURING FACILITY

Fort Bragg, California

January 2006

Prepared for:
Georgia Pacific Corporation
Atlanta, Georgia

Prepared by:
Tetra Tech, Inc.
Lafayette, California
TC 15940

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ACRONYMS AND ABBREVIATIONS

Acronym	**Definition**
“≤”	less than or equal to
“<”	less than
“>”	greater than
“≥”	greater than or equal to
°C	degrees Celsius
µg/L	Microgram(s) per liter
1,1-DCA	1,1-dichloroethane
ACM	asbestos-containing materials
AME	Acton • Mickelson • Environmental, Inc.
AOI	area(s) of interest
AST	aboveground storage tank
ASTM	American Society of Testing and Materials
BCF	bioconcentration factor
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylene
C & T	Curtis & Tompkins, Ltd.
CA LUFT	California Department of Health Services Leaking Underground Fuel Tank Manual (October 1989)
CAM	California Assessment Manual
CDP	Coastal Development Permit
CFR	Code of Federal Regulations
CHHSL	California Human Health Screening Levels
cis-1,2-DCE	cis-1,2-dichloroethene
cm	centimeter
cm^2	square centimeter
COPC	chemical(s) of potential concern
county	Mendocino County
Cr VI	hexavalent chromium
CSM	conceptual site model
d	day(s)
DCA	dichloroethane
DCE	dichloroethylene
DDAC	didecyldimethylammonium chloride
dL	deciliter
DQO	data quality objective
DTSC	Department of Toxic Substances Control
DWR	Department of Water Resources
EPA	United States Environmental Protection Agency
EPC	exposure point concentration
ERA	Ecological risk assessment

Acronym	Definition
ESA	Environmental Site Assessment
g	gram(s)
GPC	Georgia-Pacific Company
GPR	ground-penetrating radar
GPS	global positioning system
GTI	Groundwater Technology, Inc.
H_2SO_4	sulfuric acid
HASP	Health and Safety Plan
HCL	hydrochloric acid
HHERA	Human health and ecological risk assessment
HHRA	Human health risk assessment
HI	hazard index
HNO_3	nitric acid
HQ	hazard quotient
hr	hour(s)
IRIS	Integrated Risk Information System
IRM	interim remedial measure(s)
JP-5	jet fuel
kg	kilogram
L	liter(s)
LBP	lead-based paints
LCS	laboratory control sample
LEL	lower explosive limit
LFL	lower flammable limit
MB	Method Blank
MCEH	Mendocino County Department of Public Health, Division of Environmental Health
MDL	Method detection limit
MEK	2-butanone
mg/kg	milligram(s) per kilogram
mg/L	milligram(s) per liter
mg/m^3	milligram(s) per cubic meter
mL	milliliter(s)
mo	month(s)
MS/MSD	matrix spike/matrix spike duplicate
MTBE	methyl tert-butyl ether
NA	not applicable
ND	not detected
NPDES	National Pollutant Discharge Elimination System
NRHP	National Register of Historic Places
NS	no holding time specified
OEHHA	California Office of Environmental Health Hazard Assessment

Acronym	**Definition**
PAH	polycyclic aromatic hydrocarbon
PARCC	precision, accuracy, representativeness, comparability, and completeness
PCB	polychlorinated biphenyl
PCE	tetrachloroethylene
PEL	permissible exposure limit
PID	photo ionization detector
ppb	parts per billion
ppm	parts per million
ppmv	parts per million by volume
PRG	Preliminary Remediation Goals
PSH	phase separated hydrocarbon
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
QAP	Quality Assurance Plan
QL	quantitation limit
RfD	Reference dose
RL	reporting limit
RME	reasonable maximum exposure
RPD	relative percent difference
RSD	relative standard deviation
RWQCB	Regional Water Quality Control Board
SAP	Sampling and Analysis Plan
SF	slope factor
SGCU	silica gel clean-up
SOP	standard operating procedure
SVOC	semi-volatile organic compound(s)
TCE	trichloroethylene
TCLP	Toxicity Characteristic Leaching Procedure
TDEM	time domain electromagnetic metal
TMB	trimethylbenzene
TPH	total petroleum hydrocarbon(s)
TPHCWG	Total Petroleum Hydrocarbon Criteria Work Group
TPHd	total petroleum hydrocarbon as diesel
TPHg	total petroleum hydrocarbon as gasoline
TPHo	total petroleum hydrocarbon as motor oil
TRC	TRC Companies, Inc.
TRPH	total recoverable petroleum hydrocarbons
TRV	toxicity reference value
TWA	time weighted average
UCL	Upper confidence limit
USCS	Unified Soil Classification System

Acronym	**Definition**
USGS	United States Geological Survey
UST	underground storage tank
VOC	volatile organic compound(s)

1. Introduction

On behalf of Georgia Pacific Corporation (GPC), Tetra Tech, Inc. (Tetra Tech) has prepared this Human Health and Ecological Risk Assessment (HHERA) Workplan outlining the technical approach that will be followed to conduct the baseline HHERA for the Georgia-Pacific California Wood Products Manufacturing Facility (hereinafter called the Site) in Fort Bragg, California. The HHERA is being conducted to ensure that Site investigation and remediation activities achieve reasonable protection of human health and ecological resources of concern at the Site. This workplan and the HHERA are being developed in consultation with the Office of Environmental Health Hazard Assessment (OEHHA) (consultant to the North Coast Regional Water Quality Control Board [RWQCB-North Coast Region]).

Sawmill operations reportedly began at the Site in 1885. Georgia-Pacific acquired the property and began operations in 1973. On August 8, 2002, lumber production operations ceased. Sawmill operations typically consisted of receiving logs by truck, followed by on-site storage, debarking, and milling. Milled lumber was then either shipped green, kiln dried, or air-dried on site. Finished lumber was transported by rail or flatbed trailers. Bark and wood refuse was transported by truck, conveyer, or pneumatic system to the power plant where it was burned to generate steam for electricity. Other operational portions of the Site included sawmills (#1 and #2), planer buildings, fence plant, power plant, lumber storage areas, various maintenance facilities, and a seedling nursery.

This HHERA workplan presents a brief background of the Site, a description of data collected in previous investigations and planned as part of the current investigations, and technical descriptions of the proposed human health and ecological risk assessment approaches. The HHERA workplan is organized into the following sections:

- Section 1 – Introduction: provides an overview of the risk assessment, statement of project objectives, and workplan organization;
- Section 2 – Site Description provides a description of the Site;
- Section 3 – Data: provides information about data sources;
- Section 4 – Background: describes the proposed use of background data for soils and groundwater;
- Section 5 – Human Health Risk Assessment: provides a description of the human health risk assessment process, including objectives, scope of work, and technical approach;
- Section 6 – Ecological Risk Assessment: provides description of the ecological risk assessment process, including objectives, scope of work, and technical approach;
- Section 7 – References: lists all applicable references used in preparing this workplan

Appendices provide additional materials and information that will be used in support of the risk assessment.

2. Site Description

The 445-acre Site is located along the Pacific Ocean coastline in the City of Fort Bragg, California (Figure 1). The Site is located at 90 West Redwood Avenue, west of Highway One, and is bound by open coastline to the north, Noyo Bay to the south, the City of Fort Bragg to the east, and the Pacific Ocean to the west. Land elevations range from 10 to 110 feet above National Geodetic Vertical Datum (NGVD), with the majority of the Site between 40 and 90 feet NGVD (WRA 2005c).

Sawmill operations began at the Site in 1885 and ceased in 2002. Early sawmill operations occurred mainly in the vicinity of the mobile equipment shop and power plant. Over the course of 117 years of operation the sawmill operation expanded to its current size (Figure 2). The Site had a centralized mill area on the north and south sides of the log pond (Pond 8) with northern and southern areas primarily used for finished lumber and raw log storage, respectively. The southern area was largely unused for sawmill operations until a seedling nursery was established along the southeastern margin in the later years of operations. This portion of the Site also has an area where city storm drains collect in a basin and are transported to Pond 8 and eventually the Pacific Ocean. The southern area also contains a former airstrip, last used in the late 1980s. Beyond the northern boundary of the Site are undeveloped land (Blinn Trust) and the mouth of Pudding Creek. A wastewater treatment plant is located between the ocean and the mill south of Pond 8 (TRC 2003a).

Based on operational characteristics, during previous investigations by TRC Companies, Inc. (TRC) the Site was divided into 10 parcels designated as follows (Figure 3):

Parcel Number	Name	Approximate Area (acres)
1	North Coast Zone	62
2	Resaw Plant	9
3	Industrial Parcel	64
4	Power Plant Parcel	12.5
5	Sawmill #1	21
6	Planer Parcel	25
7	Sawmill #2	35
8	Log Storage Parcel	129
9	Nursery Parcel	15
10	South Coastal Zone	58

2.1 Land Use

GPC operations at the Site ceased in August 2002. Since that time, most Site equipment was removed and building and structure demolition commenced under a previously approved Coastal Development Permit (CDP). The following is a list of site operations since the shutdown of main operations:

- Holmes Lumber Company and Rossi's Building Material**:** Lease approximately 5 acres in Parcel 1 for the air drying of green rough lumber. In addition, Holmes leases sheds in Parcel 2 for storage of finished lumber.
- Pacific Marine Farms**:** Leased sheds in Parcel 2 for approximately 3 years (lease rescinded in approximately 2003) to attempt establishing an abalone farm.

- Diesel Generator**:** A 207 hp generator in Parcel 3 just north of the old construction shop used to supply electricity to Sheds 4 and 5 and construction trailer office.
- California Western Railroad**:** Stores old railroad ties and timbers used for trestle repairs in northeast corner of Parcel 3 near former Mobile Equipment Shop.
- Lowe's Reload**:** Leases Sheds 4 and 5 in Parcel 3 to store lumber for shipping to Lowe's retail stores. Lumber is bar-coded and covered with plastic bags prior to shipping. Lowe's also uses a dip tank in Shed 5 to treat lumber with anti-stain and anti fungus agents including Mycostat-P, Ferrobrite-D, and an anti-foam product.
- MCM Construction**:** Leases 5 acres in east end of Parcel 8 to store materials used in the construction of the Noyo Bridge.

Also, there are ongoing soil and groundwater investigation activities performed under the supervision of the RWQCB-North Coast Region.

Various land use types are proposed for redevelopment of the Site. GPC is working closely with the City of Fort Bragg to coordinate planning efforts to help guide reuse of the Site. One of the objectives of the City of Fort Bragg is to create a recreation area with open space. Major components of the open space framework include a Glass Beach Buffer, Coastal Trail Corridor, and Mill Pond/Wetland Restoration, including removal of storm-drain piping to restore creek discharge to the Mill Pond. Both residential and commercial developments are anticipated for portions of the Site. Also, GPC has reached an agreement to donate 38 acres of the Site along the 3- mile shoreline, which will allow a 100-foot-wide corridor for the California Coastal Trail.

2.2 Geology and Hydrogeology

2.2.1 Geology

Fort Bragg is located on the Pacific Coast of Northern California in the Coast Range Geomorphic Province. The bedrock of the region is part of the unnamed Cretaceous to Upper Jurassic marine sedimentary rocks, consisting of sandstone, shale, and conglomerate. Other units present in the Site vicinity are surface geologic units including beach and sand dunes, alluvium, and marine terrace deposits. Much of the coastal bluffs at the Site consist of Pleistocene age marine terrace deposits overlying bedrock. These marine terrace deposits are massive, semi-consolidated clay, silt, sand, and gravel, ranging from 1 to 140 feet thickness (TRC 2004a). Franciscan bedrock is exposed primarily on the tops of ridges, sporadically on the moderately steep slopes, and in area creeks, rivers, and ocean bluffs. Sandstone and shale sea mounts are very common directly offshore of the site. Marine terrace deposits consist of silty sand, gravelly sand, and lenses of gravel. Gravel lenses are frequently exposed at the base of nearly vertical banks of silty sand. In areas where a less steep slope has formed, these sediments are heavily vegetated above the high-tide zone (TRC 2004a).

According to soil boring and pothole logs completed during the Phase II Environmental Site Assessment (ESA) and 2004 Additional Site Assessment (TRC 2004b,c), the subsurface beneath the Site is primarily composed of a mixture of poorly graded, well graded, and silty sand with gravel overlying bedrock. Much of the surficial sands are fill materials overlying Quaternary marine terrace deposits of a similar nature. Some layers of clayey silt were encountered beneath the sand layers during the investigation of the Parcel 9 area.

2.2.2 Hydrogeology and Groundwater

The regional hydrogeologic setting of the Mendocino Coast where the Site is located was presented in the *Mendocino County Coastal Ground Water Study,* first published in June 1982 by the State Department of Water Resources. This area is divided into five subunits in the Coastal Groundwater Study: the Westport, Fort Bragg, Albion, Elk, and Point Arena subunits, separated by major rivers that discharge to the Pacific Ocean. The aerial extent of the Coastal Groundwater Study included all areas in which coastal terrace deposits had been mapped. The project Site is located within the Fort Bragg subunit, which extends from Big River on the south to Tenmile River on the north (TRC 2004a).

Fresh ground water is primarily obtained from shallow wells in the semi-consolidated marine terrace deposits, or through municipal or privately owned water systems. These water systems divert surface flow and springs or tap shallow alluvial aquifers (TRC 2004b). Depth to ground water has varied from approximately 1 (east area of Parcel 3) to more than 27 feet bgs (southwest area of Parcel 10) (TRC 2005).

Quarterly ground water monitoring activities conducted during 2004 (Figure 4) determined depth to groundwater ranged from 1.05 (monitoring well MW-3.6 in January 2004) to 27.42 feet below ground surface (bgs) (monitoring well MW-10.4 in September and December 2004) (TRC 2005). The ground water elevation contour map incorporates the observed hydraulic head at Pond 8, which is approximately 40.1 feet above mean sea level (msl). The inferred ground water flow direction has generally been west-southwest in the northern portion of the site (Parcels 2 and 3), northwest-to-southwest in the central portion of the site (Parcels 4 and 5), and southwest in the southern portion of the site (Parcel 10).

2.3 Surface Water Features

In addition to the Pacific Ocean and Noyo Bay located west and south of the Site, respectively, there are nine ponds located in four of the Parcels (Parcels 1, 4, 5, and 7). The largest is the Log Pond (Pond 8), which spans Parcels 4 and 5 and has been present since the inception of the mill; it received raw logs for temporary pre-processing storage and receives stormwater from the City of Fort Bragg. Based on a review of historical Sanborn maps, it appears the Log Pond was originally larger than its current configuration. The southwest extent of the Log Pond was historically larger than it is currently and extended alongside the City of Fort Bragg wastewater treatment plant property. Both the eastern and western ends of the Log Pond have been filled over time, giving the Log Pond its current configuration.

Ponds 1 through 4 are located in the southern portion of Parcel 7. These ponds consist of a Settling Pond, Aeration/Fire Pond, and two Holding Ponds. Pond 1 is a Settling Pond that received scrubber effluent from the Powerhouse. Water from Pond 1 was gravity fed to Pond 2 (Aeration/Fire Pond), where cyanide levels in the water were reduced. Water from the Aeration Pond was piped west to Pond 3 (Holding Pond) before eventually being pumped to the west end of the Log Pond.

Ponds 6 and 7 are located in Parcel 4. Pond 6 (Collection Pond) was used to collect and evaporate stormwater runoff. Similar to Pond 1, Pond 7 (South Settling Pond) was used as a receiving basin for scrubber effluent from the Powerhouse. Pond 9 (Parcel 1) was used as a source of water for fire hydrants in the vicinity.

A vegetated area along Highway 1 in the eastern portion of Parcel 9 contains a catch basin at its northern end that receives drainage from the City of Fort Bragg through underground piping and discharge from a stream channel located along the west side of the area. The stream channel receives stormwater from the Nursery Area and contains standing water during most of the year. An assessment of jurisdictional waters in this area considered the catch basin and stream channel to be part of a wetland as they form part of a natural drainage course and contain flora typical of wetland areas (TRC 2004d; WRA 2005c). The vegetated area was not considered to be a wetland as it is separated from the catch basin by an upland area and did not exhibit the characteristics of typical wetland vegetation, soil type, and hydrology (TRC 2004d).

2.4 Climate

The Site is located in Mendocino County along the Pacific Ocean coast of northern California. Temperatures vary from an average winter low of 40.0 degrees Fahrenheit to an average summer high of 65.3 degrees Fahrenheit (WRCC 2005). The mean annual precipitation recorded for Fort Bragg is about 41 inches per year, ranging from 21 to 62 inches per year. Precipitation occurs primarily during the winter months, with over 90 percent occurring between October and April (WRCC 2005). Summers are characterized by fog, cool temperatures, and high humidity.

2.5 Habitats

Potentially affected habitats at the Site were evaluated by TRC in March 2003 and summarized in a report titled *Jurisdictional Determination and Habitat Assessment* (TRC 2003a). Subsequent biological surveys were conducted in the spring and summer of 2005 by WRA, and included a *Biological Assessment* (WRA 2005a), *Assessment of Environmentally Sensitive Habitat Areas (ESHAs)* (WRA 2005b), and *Delineation of Potential Section 404 Jurisdictional Wetlands and Waters* (WRA 2005c).

The Site is located on the northern California coast, between the northern California Coast Ranges and the Pacific Ocean. The Site is within Fort Bragg Terraces Subsection (263Ah) of the Ecological Subregions of California classification system (USDA 1997). Dominant wildlife habitats on the Site include annual grassland, freshwater emergent wetland, and limited areas of red alder-dominated woodland (Mayer and Laudenslayer 1998; USDA 1997). Marine coastal habitat (approximately 3 miles) is present along the western edge of the Site.

WRA (2005b) identified five types of ESHAs as being present on the Site: Streams (2 areas), Riparian habitat (2 areas), Coastal Bluffs, Coastal waters, and Intertidal/Marine areas. A total area of 12.59 acres of wetlands, 0.16 acre of streams, and 6.48 acres of riparian habitat located primarily in Parcels 4, 5, and 7 were classified as ESHAs.

In general, habitat at the Site is highly disturbed. A large portion of the Site (approximately 80 percent) is covered with asphalt, crushed rock, or a mixture of both. Vegetated areas exist along the northern edge of the power plant north of Pond 8; along the eastern edge of the property north of the nursery area; west of the airstrip; and south of the Log Deck area. The area north of the airstrip abuts the rocky shoreline of the Pacific Ocean. One bay known as Soldier Bay (aka Fort Bragg Landing) cuts into the rocky shoreline and terminates at a beach and the dam and overflow structure from Pond 8 are along the southern edge. Based on observations at the Site (TRC 2003a), five major habitat areas were identified:

- Industrial Ponds,
- Nursery Area,
- Wetland Area North of the Power Plant,
- Soldier Bay Beach, and
- Southern Edge of Property.

The Site has nine industrial ponds that were used for a variety of industrial purposes and are now being evaluated for closure. These industrial ponds provide habitat for wetland and aquatic vegetation. As part of the wetland delineations each pond or other wetland feature was evaluated to identify jurisdictional waters (TRC 2003a; WRA 2005c). Ten potential jurisdictional (i.e., subject to Section 404 of the Clean Water Act) wetland areas were identified by WRA (Appendix C in WRA 2005c). These wetland areas are located primarily in Parcels 4, 5, and 7. A small canyon on the south side of Parcel 10 supports a riparian wetland. Fifteen wetlands and other waters were considered as potentially exempt from Corps of Engineers jurisdiction by WRA. These areas include eight ponds that were constructed for industrial purposes in upland areas and are not part of natural drainage courses.

Soldier Bay Beach is adjacent to the western edge of the Site in the vicinity of the power plant. The eastern (landward) margin of the beach is rip rapped with concrete and rock that supports a north-south road. The overflow from the dam of Pond 8 (Log Pond) flows to the sea along the southern edge of the beach. Four stormwater drainpipes terminate at the beach, and appear to drain from the direction of the sawmill. Only two were flowing at the northern end of the beach during a steady rainstorm on March 13, 2003 (TRC 2003a).

These ecologically important areas are discussed in more detail in the ecological risk assessment approach (Section 6).

2.6 Cultural Resources

An archaeological assessment to identify Site cultural resources was conducted in March 2003 (TRC 2003b). The assessment identified eight prehistoric and three historic locations. The Site was determined to possibly be eligible for listing in the California Register as an historic district. Much of the Site was covered by vegetation, pavement, or buildings and therefore was not accessible during the study.

Some of the buildings are more than 45 years old and were recommended for evaluation by an architectural historian before their removal. The report also recommended development of a site-specific cultural resource treatment plan that would detail measures to be taken to mitigate negative cultural resource impacts on the site (TRC 2003b).

The *Draft Phase II Determination of Significance Standing Structures* (TRC n.d.) report concluded that the Site is eligible for placement in the National Register of Historic Places (NRHP)/California Register under four criteria:

1. As an historic district for its association with development of the redwood lumber industry and the history and development of the City of Fort Bragg ;
2. For its association with C.R. Johnson, founder and former president of the Union Lumber Company;
3. For its unique buildings and equipment associated with the mill's historic use; and
4. For its potential to contribute data relevant to our understanding of development of the redwood lumber industry (TRC n.d.).

The draft *Site Specific Treatment Plan for Cultural Resources* (TRC n.d.) concluded that specific areas contain a moderate to high potential for subsurface historic cultural resources and recommended that an archaeologist and Native American representative be present during any intrusive work to characterize these features (TRC n.d.).

3. Data Sources

A synthesis of past and current Site investigation results will serve as the basis of the HHERA. The past investigations consist primarily of a Phase 2 ESA and supplemental investigations conducted in 2004 (TRC 2004b,c). The past investigations and results are briefly described below in Section 3.1. Currently, two additional investigations are planned or underway at the Site. These two investigations are intended to address (1) contamination potentially beneath building foundations that are proposed for removal (AME 2005a); and (2) additional areas of contamination not addressed under the CDP permit (AME 2005b). The general scope of these two investigations is described below in Section 3.2. In addition, groundwater will be characterized by examining the previously collected groundwater monitoring data and that collected during the ongoing quarterly monitoring program.

All data will be examined to ensure that quality assurance/quality control (QA/QC) procedures have been adhered to and that the data are of sufficient quality to support an HHERA. To the extent possible, the USEPA (1992d, 2000a) data quality assessment (DQA) process and will be followed to verify that the type, quality, and quantity of data collected are appropriate for risk assessment purposes. Data quality and data usability will be assessed systematically to include 1) a review of the sampling design and sampling methods to verify that they were implemented as planned; 2) a review of project-specific data quality indicators ; and 3) an evaluation of any limitations associated with the decisions to be made based on the data collected. The data evaluation will be described in the HHERA report.

3.1 Summary of Previous Investigations

This section provides a review of previous investigations conducted in 1992, 1998, and from 2001 to 2004. Figures 2 and 3 show the locations of parcels, major buildings, ponds, and other features.

3.1.1 Investigation (1992)

In 1992, Groundwater Technology, Inc. (GTI) conducted an investigation at the two Bunker C fuel aboveground storage tanks (ASTs) located east of the Water Treatment Plant in Parcel 4. The investigation included 15 soil borings with grab ground water sampling. Soil samples were collected from 2 to 6 feet bgs for laboratory analysis of TRPH using EPA Method 418.1. Soil sample total recoverable petroleum hydrocarbon (TRPH) concentrations were greater than 100 milligrams per kilogram (mg/kg) at four soil boring locations in this area. Ground water sample TRPH concentrations ranged up to 200 milligrams per liter (mg/L) in the same area. The environmental assessment report concluded that the area southeast of the tank containment was impacted by heavy end petroleum hydrocarbons (GTI 1992).

3.1.2 Investigation (1998)

In 1998, TRC performed an investigation of Sawmill #1, the Lath Plant, Planers #1 and #50, and the Green Chain north of Sawmill #1. Soil samples were collected at 0.5 and 2.5 feet below ground surface (bgs) at each building or structure and analyzed for total petroleum hydrocarbons (TPH) as diesel (TPHd), TPH as motor oil (TPHo), and polychlorinated biphenyls (PCBs). Laboratory results reported TPHd and TPHo concentrations at both sample depths at the east and west ends of Sawmill #1 and in the southern half of Planer #1. Near-surface soil was impacted with TPHd and/or TPHo at one sampling location in the Lath Plant and one sampling location beneath the Green Chain (TRC 1998)

3.1.3 Phase I Environmental Site Assessment

A Phase I ESA was conducted by TRC from 2001 to 2004 (TRC 2004a) and included:

- Visual inspections of each parcel for environmental concerns;
- A site-history survey including historical Sanborn maps, historical United States Geological Survey (USGS) maps, and aerial photograph review;
- A visual survey of buildings for asbestos-containing materials (ACM) and lead-based paints (LBP);
- Communication with local and Mendocino County regulatory agencies; and
- A computer-database search of sites with environmental concerns within a 1-mile radius of the site.

The Phase I ESA report divided the Site into ten parcels, generally based on building types and land usage (see Section 2), and identified approximately 40 areas of potential environmental impact within the parcels. The primary areas of interest (AOIs) were located in Parcels 3, 4, and 5. Potential environmental impacts were also identified in the remaining parcels, though generally to a lesser degree.

3.1.4 Phase II Environmental Site Assessment

A Phase II ESA was performed by TRC from 2003 to 2004 (TRC 2004b) and included:

- Approximately 160 soil borings (with soil and grab ground water sampling);
- 70 potholes;
- Installation of 30 ground water monitoring wells; and
- Geophysical surveys to search for buried items.

Laboratory tests were conducted for TPH as gasoline (TPHg), TPHd, TPHo, California Title 22 list of 17 metals (CA Title 22 metals), volatile and semi-volatile organic compounds (VOCs and SVOCs), polychlorinated biphenyls (PCBs), pesticides, and herbicides. Grab ground water samples collected at the Former Mobile Equipment Shop and Machine Shop in Parcel 3 and the Mobile Equipment Shop in Parcel 5 were reported to contain hydrocarbons; however, subsequent monitoring well ground water samples collected in the same area contained lesser reported concentrations of hydrocarbons, with the exception of the sample from upgradient monitoring well MW-3.2.

The hydrocarbon impacts to soil were identified in a number of locations, including:

- Glue Lam and Resaw #5 Areas (Parcel 2);
- Former Mobile Equipment Shop, Compressor House, Covered Shed, and Machine Shop Areas (Parcel 3);
- Powerhouse Area (Parcel 4);
- Former Sawmill #1 and Mobile Equipment Shop (Parcel 5);
- Northwest corner of Planer #2 and Shipping Office (Parcel 6); and
- Beehive Burner and Fuel ASTs (Parcel 7).

VOCs were reported in soil samples collected at:

- Resaw #5 Area (Parcel 2);
- Former Mobile Equipment Shop Area (Parcel 3);
- Powerhouse Area (Parcel 4); and
- East Log Pond Fill Area and Mobile Equipment Shop (Parcel 5).

Pesticides were reported in soil and grab ground water samples collected in the tree Nursery Area in Parcel 9 (TRC 2004b).

3.1.5 Additional Site Assessment and Ground Water Monitoring (2004)

An additional site assessment was conducted by TRC in 2004 in response to written comments from the RWQCB – North Coast Region on the Phase I and Phase II ESAs. The investigation included potholes and soil borings with soil sampling in the following areas:

- Near the Former Compressor House, Former Scrap Yard, Former Mobile Equipment Shop, Machine Shop, and Covered Shed (Parcel 3);
- Powerhouse and Bunker Fuel AST Areas (Parcel 4);
- East Log Pond Fill Areas (Parcel 5);
- West Log Pond Fill Area and Planer #2 (Parcel 6);
- Sawmill #2 and Mill Ramp Area (Parcel 7);
- Coastal Disturbance Area (Parcel 8); and
- Former Tree Nursery (Parcel 9).

The additional site assessment (TRC 2004c) also included geophysical surveys at the Former Scrap Yard (Parcel 3) and Fill Material Area (Parcel 10). Soil samples were analyzed for TPHd, Toxicity Characteristic Leaching Procedure (TCLP) for TPHd, TPHo, TCLP for TPHo, VOCs, SVOCs, polycyclic aromatic hydrocarbons (PAHs), and CA Title 22 metals.

TRC concluded that detectable levels of metals, VOCs, and SVOCs were less than United States Environmental Protection Agency (USEPA) Preliminary Remediation Goals (PRGs), often used as a screening measure of the need for site cleanup (TRC 2004c).

Quarterly ground water monitoring activities were conducted by TRC through 2004 (TRC 2005). Reported TPHd and TPHo concentrations in ground water samples from monitoring well MW-5.5 ranged up to 610 and 2,100 micrograms per liter (μg/L), respectively. Reported concentrations of TPHg and TPHd ranged up to 180 and 560 μg/L, respectively, in ground water samples from monitoring well MW-3.2 located upgradient of the Former Mobile Equipment Shop in Parcel 3. A phase separated hydrocarbon (PSH) thickness of 0.01 foot was reported in monitoring well MW-5.1 near the Mobile Equipment Shop in Parcel 5 in June, September, and December of 2004.

Chlorinated VOCs and fuel-related VOCs, particularly methyl tert-butyl ether (MTBE), were reported in ground water samples from Parcel 3 monitoring wells MW-3.1, MW-3.2, and MW-3.3 and Parcel 5 monitoring wells MW-5.1, MW-5.3, MW-5.4, MW-5.6, and MW-5.7. Naphthalene and phenanthrene, both PAHs, were reported in ground water samples from monitoring wells MW-3.2 and MW-5.7, respectively. Barium concentrations up to 9,600 μg/L were reported in ground water samples from monitoring well MW-4.1 (TRC 2005).

3.2 Current Investigations

3.2.1 Work Plan for Foundation Removal, Additional Investigation, and Interim Remedial Measures

In March 2005, a Workplan to conduct additional Site investigations was submitted by Acton • Mickelson • Environmental, Inc. (AME 2005a) in behalf of GPC to support an application for a Coastal Development Permit (CDP). The scope of this workplan, as supplemented by *Addendum #1 Work Plan for Foundation Removal, Additional Investigation, and Interim Remedial Measures* dated May 6, 2005 (Addendum #1) addresses:

- Investigation of 11 areas containing building structures, including the compressor house, former sawmill #1, powerhouse, fuel barn, chipper building, water treatment plant, powerhouse fuel storage building, and the water supply switch building, the sewage pumping station, dewatering slabs, , and the former mobile equipment shop;
- Removal of debris from three beach areas (Glass Beaches #1 through #3); and
- Removal of two areas of geophysical anomalies, identified in the September 3, 2004 report titled *Geophysical Investigation of Parcels 3 and 10 of the Former Georgia Pacific Sawmill site in Fort Bragg, California* prepared by 3Dgeophysics (AME 2005a).

The scope of work will also address foundation removal and excavation of impacted unsaturated soil, if applicable, at approximately 29 building structures. Following foundation removal, soil samples will be collected from areas underlying or adjacent to foundation staining or cracks, drain lines, or previous sampling locations where chemicals were reported at concentrations greater than the reporting limit (RL). Other locations observed during foundation removal or suspected to be impacted by chemical releases will also be sampled. Depending on the location and past history of each area to be sampled, the soils will be analyzed using the following test methods:

- Total petroleum hydrocarbons as gasoline, diesel, and motor oil (EPA Method 8015 Modified)
- Total petroleum hydrocarbons as diesel with silica gel cleanup (EPA Method 8015Modified) – Extended Chromatogram
- Total oil and grease (EPA Method 1664A)
- Volatile organic compounds (EPA Method 8260)
- Volatile organic compounds (EPA Method 8260 with sample collection by EPA Method 5035)
- Semi-volatile organic compounds (EPA Method 8270)
- Polycyclic aromatic hydrocarbons (EPA Method 8310)
- Polychlorinated biphenyls (EPA Method 8080 or 8082)
- Organochlorine pesticides (EPA Method 8081)
- Dioxins and furans (EPA Method 8280 or 8290)
- Site specific pesticides/herbicides (various methods)

- CAM 17 Metals (EPA 6010/7400)
- Hexavalent chromium (EPA Method 7196)
- Tannin and lignin (to be determined).

The specific analyses to be conducted in each area are summarized in Appendix A.

The scope of work outlined in the workplan requires approval of the CDP Application by the City of Fort Bragg prior to initiation of field activities. On October 5, 2005, the workplan, as modified by the AME submittals dated May 6, 2005, July 18, 2005, August 19, 2005, September 22, 2005, and September 28, 2005, were approved by the RWQCB-North Coast Region. Currently the CDP permit is under appeal and, therefore, field investigations will not be conducted until decisions are made regarding approval of the permit.

3.2.2 Work Plan for Additional Site Assessment

In June 2005 another Work Plan to conduct additional Site assessment was submitted by AME to address recommendations made by the previous consultant (TRC), and address comments made by the RWQCB – North Coast Region regarding prior investigations. The main objectives of the Site assessment are:

- Evaluate the extent of impacts of chemicals of potential concern (COPCs) in Site soil, ground water, surface water, and sediments;
- Investigate additional areas of concern identified subsequent to previous Site investigation activities;
- Characterize the Site and provide representative concentration data for chemicals of potential concern (COPCs) in soil, ground water, surface water, and sediments to support a human health and ecological risk-assessment.

The site assessment activities are intended to investigate areas not included in the Work Plan submitted in March 2005 (AME 2005a).

The Work Plan presented evaluations of historical processes, waste streams, and existing analytical data to support selection of the chemicals to be analyzed in each area of interest (AOI) within the 10 Parcels being investigated.

Specific objectives of the site assessment activities proposed in the Work Plan include the following:

- Collect and analyze samples in accordance with the data quality objectives (DQOs) to evaluate the extent of chemical impacts in surface soil (0 to 2 feet bgs), deeper soil (below 2 feet bgs), ground water, surface water, and sediments at the Site.
- Characterize additional fill areas identified subsequent to previous site investigation activities. Specific objectives include: 1) characterize the lateral and vertical extent of the fill area; 2) identify areas of buried metal and other debris; 3) identify areas of elevated soil conductivity that may suggest the presence of COPC impacts; and 4) evaluate concentrations of COPCs in identified fill materials.
- Characterize waste materials (e.g. clinker ash/scrap piles) to evaluate removal and disposal options.

- Collect and analyze samples to obtain representative concentration data for COPCs in surface water, pond sediments, and storm drain sediments.
- Investigate the depth of pond sediments.
- As warranted, collect soil samples to provide background dataset(s) to use as naturally occurring chemical concentrations, particularly for metals. A workplan for background sampling is being developed separately.
- Provide for the evaluation of temporal changes in chemical concentrations in ground water near source areas, downgradient locations, and/or potential exposure pathways through the installation of ground water monitoring wells.
- Characterize ground water flow directions and gradients through the installation of monitoring wells and piezometers.

The Work Plan (AME 2005b) proposed collection of the following types of data to meet the stated objectives of the Site assessment:

- Geophysical survey of areas of fill materials, with identified anomalies indicative of potential buried debris and/or waste and lateral variations in soil conditions;
- Sample analytical data for concentrations of chemicals in surface soil (0 to 2 feet bgs), deeper soil (below 2 feet bgs), ground water, surface water, sediments, fill materials, and waste material at the site;
- Lithologic descriptions of soil, fill materials, and pond sediments extending to native soil in the case of fill materials and pond sediments;
- Periodic ground water elevation data and ground water analytical data from ground water monitoring wells;
- Surveyed sample locations and ground water monitoring well locations and elevations; and
- Storm drain locations and general surface water flow patterns

The specific scope of work proposed for individual areas varies depending on past history and investigation results. The rationale for the proposed sampling and chemical analyses is provided in detail in the Workplan. The sample number, location, and analyses proposed for soils, sediments, surface waters, and groundwater are summarized in a table presented in Appendix A.

On September 19, 2005, this Work Plan, as modified by submittals dated August 18, 2005 and September 16, 2005, and a request to use EPA Method 5035 in the collection and preservation of soil samples for VOC and TPH-g analyses, was approved by the RWQCB—North Coast Region. The investigatory activities are currently being implemented at the Site.

3.2.3 Investigation Support

Soil and groundwater screening levels will be used as a guide to determine whether additional investigation or possibly Interim Removal Measures are warranted. Preliminary risk-based screening criteria (RBSCs) were developed as part of this current Work Plan to assist in Site characterization by identifying chemicals and/or areas requiring additional evaluation (e.g., further characterization or removal) (Appendix B). The RBSCs are not intended as chemical concentrations that are acceptable to remain in soil or groundwater.

Risk-based screening criteria (RBSCs) are chemical-specific soil or groundwater concentrations that result in a predetermined level of risk or hazard. As described in detail in Appendix B, preliminary sets of RBSCs for human health and ecological effects were developed for one set of chemicals detected in soils across the Site and one set of chemicals detected in groundwater, based on the available investigation data (TRC 2004b,c) (Appendix B). Also, as described in Appendix B (with supporting information in Attachments B-2 and B-3), RBSCs for human health and ecological receptors were developed using health protective assumptions in the assumed exposure parameters and toxicity data. Surface water and sediment sampling results were not available at this time. Thus, the chemicals detected in these environmental media will need to be evaluated when the data are available.

4. Background Evaluation

Background can be defined as the concentrations of constituents in an environmental medium, such as soil, that are naturally occurring from undisturbed geologic sources or that occur solely from a source other than man's activities at the Site. USEPA (1989) and DTSC (1997) guidance recommend the screening of Site metal concentrations against background metal concentrations during the process of identifying chemicals of potential concern (COPCs). Metal concentrations in Site soils and groundwater that fall within the range of background concentrations do not need to be selected as COPCs, and therefore, would not require further evaluation (DTSC 1997).

Background should be established based on the local geographical area and should include available information to select representative samples unimpacted by site activities (DTSC 1997). The background sampling locations should consider the natural variability of constituents in a medium and processes such as erosion, weathering, and dissolution of mineral deposits that could cause variability.

A supplemental investigation is proposed to identify and sample background locations that can be used to identify metals of potential in soils at the Site. The background locations are being proposed on the basis of a review of available surficial geology and soil type maps, maps and other information on historical site operations,, and the results of the Site investigations. In addition, potential locations will be inspected for their suitability. Background sample locations will allow an assessment of the natural heterogeneity of the Site soils. The entire geological review and proposed background sampling results will be provided in a separate report. The background dataset and analytical methodology will be approved by the RWQCB-North Coast Region and OEHHA prior to initiating the risk assessment.

On the basis of DTSC (1997) guidance, which states that the best description of ambient metal concentrations is obtained from the largest data set possible, the background dataset may be expanded using ambient concentrations, as described in Appendix C. A technical memorandum describing the derivation of background metals concentrations will be prepared and submitted for review after completion of the local background study.

The background metal concentrations determined for this Site will be used in identifying metals as COPCs for this Site. In accordance with DTSC (1997) guidance, the comparison of Site soil metals concentrations to background metals concentration is an iterative process whereby the first step is a simple comparison of maximum Site metals concentrations to upper bound (e.g., 95th percentile) background metals concentrations. When the maximum detected site metal concentration falls below the upper bound background metal concentration for a given metal, it may be concluded that Site metal concentrations are within the range of background metal concentrations.

The second step involves a more robust statistical analysis that is employed in cases where maximum Site metals concentrations exceed upper bound background metals concentrations. Use of this approach is important because failing the simple comparison method described above does not necessarily mean that the distribution of Site metal concentrations is not within the range of background metals concentrations. In these cases, DTSC (1997) and USEPA (2000, 2002a) guidance will be followed to statistically compare Site metal concentration distributions against background metal distributions.

A similar evaluation will be conducted for metals detected in groundwater as proposed for soils. Background metal concentrations will likely be developed using data from the four most recent of the available monitoring events, assuming a set of upgradient groundwater monitoring wells can be identified that are considered unimpacted by Site-related activities. The monitoring wells and data selected as background groundwater conditions will be provided for review and approval by the RWQCB-North Coast Region and OEHHA, prior to conducting background comparisons.

Ambient concentrations of dioxins and furans and the potential sources of these chemicals have been described in a report developed for this Site (Exponent 2004). Thus, dioxin concentrations detected in soils at this Site will be compared to ambient concentrations in soils. Only those concentrations exceeding ambient concentrations will be evaluated in the risk assessment.

5. Human Health and Ecological Risk Assessment

The risk assessment and management process is based on the principle of decision and action using a systematic approach. The overarching goal of the process is to evaluate data and relevant risk assessment information in a step-wise fashion that allows for advancement along the path towards Site or facility closure within the regulatory framework. A key outcome of this approach is that it enables risk assessment professionals to adapt the risk assessment process to best fit the environmental conditions present at a given site. The HHERA will provide an evaluation of the potential human health and ecological risks for current and future conditions. The key components of the HHERA will include:

Human Health Risk Assessment (HHRA):

- Identification of chemicals of potential concern (COPCs);
- Assessment of the potential chemical exposures;
- Assessment of toxic effects of the chemicals of potential concern; and
- Estimation of risks and analysis of uncertainties.

Ecological Risk Assessment (ERA):

- Identification of areas, receptors, and exposure pathways (Problem Formulation Phase);
- Selection of indicator species, toxicity reference values, and estimation of exposure (Analysis Phase); and
- Risk estimate calculation, background risk comparison, risk interpretation, and uncertainty analysis discussion (Risk Characterization Phase)

The risk assessment will be consistent with guidance developed by the USEPA in the *Risk Assessment Guidance for Superfund* (RAGS) (USEPA 1989, 1990a, 1991a, 1991b, 1992a, 1992b, 1996a, 1996b, 1997a, 2000a, 2003, 2002a,b,c, 2004a,b,c,), *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments - Interim Final* (USEPA 1997), *Guidelines for Ecological Risk Assessment* (USEPA 1998), *Supplemental Guidance for Human Health Multimedia Risk Assessments of Hazardous Waste Sites and Permitted Facilities* (DTSC 1992), *Preliminary Endangerment Assessment Guidance* (DTSC 1999), and *Guidance for Ecological Risk Assessment at Hazardous Waste Sites and Permitted Facilities* (DTSC 1996). The approach for conducting the HHRA is described in the following sections of Section 5, while the approach for conducting the ERA is described in Section 6.

5.1 Identification of Chemicals of Potential Concern

Chemicals of potential concern (COPCs) are chemicals that have the potential to adversely affect human health or the environment. Chemical releases at this Site may have occurred during approximately 115 years of past Site activities. As discussed in Section 2, sawmill operations, including the power plant, log and lumber storage areas, various maintenance facilities, and a seedling nursery, could have released chemicals as a result of past activities, although much of the operational equipment and structural components have been removed since the cessation of on-site operations. Further, interim removal activities are proposed as a part of the foundation removal activities. As indicated in Section 3, past and current investigations have been conducted or are proposed to determine the nature and extent of environmental impacts from past Site operations. Thus, the COPCs will be identified using the analytical results determined to be useable for risk assessment purposes (as per USEPA 1992d, 2000b) from the recent and proposed Site investigations.

Four environmental media have been sampled or are planned to be sampled: soil, groundwater, surface water, and sediment. COPCs will be identified within each of the sampled environmental media. Based on review of the data previously collected by TRC (2004b,c) in excess of 74 analytes have been detected. Additional analytes are likely to be detected in the current and proposed field sampling investigations. The approach for evaluating the results of the sampling of these media is described below.

All chemicals detected in soils, groundwater, sediment, and surface water from recent and historical investigations will be initially considered candidate COPCs. In accordance with USEPA (1989) and DTSC (1999) risk assessment guidance, chemicals that are site-related and frequently detected in Site media may require further evaluation. Consistent with this guidance, metals detected at concentrations that fall within the range of local or ambient background concentrations are not likely site-related and thus would not require further evaluation. As indicated in Section 4, identification of metals as COPCs will be based on comparisons to upperbound background concentrations or statistical comparisons, as appropriate. Based on USEPA (1989) and DTSC guidance (1992, 1999) all organic constituents will likely be considered, although essential nutrients and common laboratory contaminants detected at low concentrations and not known to be site-related, may also be excluded from further evaluation.

USEPA (1989) guidance indicates that constituents considered to be essential human nutrients that are toxic only at high doses do not need to be evaluated in a quantitative risk assessment. Essential nutrients such as calcium, iron, magnesium, potassium, and sodium, therefore, will not be selected as COPCs.

Infrequently detected compounds may represent laboratory contamination, false positives, or evidence of contamination. Compounds that are infrequently detected will be evaluated to determine whether they could be excluded from the risk assessment. This evaluation will include consideration of the likelihood that it is associated past Site operations or possibly with laboratory analyses (e.g., phthalates from rubber tubing, or acetone from cleaning of laboratory glassware or sample preparation). Laboratory reports will be examined to determine whether common laboratory contaminants are reported in any of the field or laboratory blank QA/QC samples. The presence of the compound in other environmental media will also be considered. Compounds whose detected concentrations are consistently close to the detection limit may represent laboratory contamination. Those compounds detected at low concentrations in Site media and likely to be laboratory contamination may therefore be excluded from further evaluation. The rationale for excluding any sample results will be provided as part of the HHERA data review process.

Separate sets of COPCs will be identified for surface and subsurface soils. As discussed in Section 5.2 below, those chemicals detected in surface soils (e.g., the top 2 feet of soils) and any volatile chemicals detected in subsurface soils are those that several groups of future receptors could potentially be exposed to at this Site. Depending on the receptor and their future onsite activities, however, exposures could occur to COPCs in different soil layers. This distinction of COPCs in surface and subsurface soils, therefore, will aid in the evaluation of potential future exposures for each group of evaluated receptors.

The monitoring wells installed by TRC (2004b) have been sampled quarterly in 2004 and 2005. Additional wells are being installed during the current investigations. Groundwater monitoring data from all of these wells will be evaluated in determining the COPCs in groundwater. The most recent data available for four monitoring events (i.e., one year) will be used preferentially in identifying COPCs in groundwater, as is typically preferred by the RWQCB. Nevertheless, all available data will be included in this evaluation process to ensure that highly toxic chemicals or chemicals detected in wells not sampled recently are considered in identifying COPCs in groundwater. The analyses will be examined using an approach similar to that for soils, wherein metals will be compared to background concentrations (if available) and all organics as considered candidate COPCs. This evaluation will also consider the potential influence of upgradient sources of certain organics, such as methyl tert-butyl ether (MTBE) from gasoline releases at nearby gas stations. Although these compounds will likely be identified as COPCs, risks estimated for exposures to the compounds may be subtracted from site-related risk estimates. Grab groundwater samples will not be used for identifying COPCs or quantifying exposures in the risk assessment.

COPCs will be identified for surface water and sediments, if appropriate, although it is currently uncertain to what extent future receptors may be exposed to these environmental media.

Compounds detected in soil and groundwater, in particular, will also be evaluated to identify COPCs that could be emitted to the atmosphere. The evaluations will include identification of both volatile and non-volatile COPCs. The procedures for identifying these two types of COPCs are described below in Section 5.2.2.

5.2 Exposure Assessment

An exposure assessment will be conducted to estimate the type, timing, and magnitude of exposures that receptors may experience due to contact with the COPCs. The primary goals of the exposure assessment will consist of:

- Characterization of the Site setting and potentially exposed human receptors;
- Identification and evaluation of potentially complete exposure pathways resulting in receptor exposure to COPCs; and
- Quantitative assessment of chemical intakes using measured and predicted chemical concentrations.

The identification of potentially complete exposure pathways will be based on the conceptual site model (CSM) developed for this Site. As shown in Figure 5, this CSM is based on the Site's past history and the potential future Site uses. The CSM shows the potential links between contaminant sources at the site, the COPCs, the mechanisms by which contaminant transport or migration may occur in the environment, and the receptors potentially exposed to the COPCs.

The Site setting provides a framework for characterizing the population potentially exposed to the COPCs. As indicated above, sawmill operations ceased in 2002. At present, future development plans are uncertain, with a number of different options under consideration. To date, the only relatively firm plans involve the proposed development of a shoreline trail that could be used for hiking, nature study, photography, bird watching, wildlife viewing or other casual recreational activities. Other future uses of the Site are likely to consist of a combination of residential, commercial/industrial, and open space components, although no definitive plans have been developed. In the interim, a few areas or buildings on the Site are being leased primarily for storage of materials and equipment by commercial operations (see Section 2). Under future conditions, several types of receptors could potentially be exposed to COPCs, depending on the specific use of the land in different portions of the Site. The future receptor groups could include on-site residents, commercial/industrial workers, construction workers, and open-space visitors. These types of future Site receptors could potentially be exposed to COPCs as a result of several complete exposure pathways involving soil, groundwater, surface water, or sediment.

5.2.1 Exposure Pathways

A key aspect of the risk assessment is determining potentially complete exposure pathways, which describe the course that chemicals may take from a source to an exposed individual. In order for an individual receptor to be exposed to the COPCs, plausible routes of exposure will be examined. Four factors will be used to identify potentially complete exposure pathways:

- Chemical source;
- Contaminated medium (e.g., soil, groundwater);
- Exposure or contact point with the contaminated medium (e.g., dermal contact with soil); and
- Exposure route for chemical intake by a receptor (e.g., inhalation).

Complete exposure pathways will be determined for each receptor group, including evaluations of potential exposure to COPCs via the primary routes of chemical exposure: ingestion, inhalation (e.g., vapors), and dermal contact. Evidence for other potential exposure routes will also be examined. Based on currently available development scenarios, a CSM was developed to show the potentially complete exposure pathways for future on-site receptors (see Figure 5). The HHRA will present the rationale for retaining or eliminating specific receptor exposure pathways for quantitative evaluation.

Based on our understanding of plans for future uses of the Site, all four groups of future receptors may directly contact soils. Future on-site residents are most likely to contact surface soils (0-2 feet bgs). However, to be consistent with DTSC (1992) guidance, it will be assumed that future on-site residents may be exposed to a combination of surface and subsurface soils (0-10 feet bgs) potentially excavated and spread on the surface. The subsurface depth interval may vary across the Site, since groundwater occurs at depths as shallow as 1 foot bgs and, therefore, there is only a thin layer of unsaturated soils. Future industrial workers and open-space visitors are likely to only directly contact surface soils, whereas construction workers may contact surface and subsurface soils. Direct soil contact is likely to result in the incidental ingestion of soil and dermal contact with soil. Direct soil contact would result in exposure to the COPCs detected in soil.

Because of the low molecular weight and high vapor pressures of the VOCs and certain SVOCs, these COPCs may volatilize from soils and from groundwater into the atmosphere. Volatilization of VOCs and SVOCs is likely to be unimpeded because groundwater is relatively shallow (ranging from about 1 to 10 feet bgs) at this Site and, thus, vapor migration will only be through a relatively thin layer of unsaturated soils. Additionally, since the majority of the Site is currently not paved, there is no barrier to vapor emissions. Future on-site receptors could therefore be exposed to VOCs or SVOCs detected in soils or groundwater via inhalation of airborne vapors. Similarly, since buildings may be constructed on the Site, future exposure to vapors in indoor air will be considered for future on-site residents and industrial/commercial workers, where appropriate.

In contrast to the VOCs, organic compounds with low volatility (including PCBs) typically have a high molecular weight and low water solubility. These properties result in the adsorption of these compounds to soils. Metals behave similarly, adsorbing to soil particulates. Soil disturbance by wind or construction activities could result in the emission of soil particulates and the adsorbed constituents. Subsequent atmospheric transport of these particulates could result in the inhalation of airborne dusts and associated COPCs by on-site receptors.

Residential land uses could result in the planting of backyard gardens. Also, agricultural development is one of the proposed future uses of at least part of the Site. Constituents detected in soils could be taken up by this produce. Consequently, homegrown produce or other agricultural products may be consumed by on-site residents or other receptors. Based on this information, the health protective assumption was made that consumption of homegrown produce may be a potentially complete exposure pathway.

Groundwater exposure pathways are likely to be incomplete for human receptors at this Site because groundwater is not used for water supply purposes. Future use of groundwater as a drinking water supply is also unlikely because insufficient shallow groundwater may be available to supply even a single well capable of producing an average, sustained yield of 200 gallons per day (SWRCB 1988). However, in order to evaluate potential impacts to a drinking water resource, it is assumed that groundwater may be used as a potable water source. Also, given the shallow groundwater, VOCs detected in groundwater may be emitted through the soils into the atmosphere or indoor air.

Nine ponds have been identified at this Site and sampling of both surface water and sediment is planned for each of these ponds. However, only Pond 8 (the log pond), Pond 6, and the de-barker pond have been identified as potential jurisdictional wetlands (WRA 2005c). Pond 6 and the de-barker pond are located west of the former fuel barn and adjacent to the berm at the head of Soldier Bay. The other industrial ponds could potentially be filled as part of Site development. Thus, in the future, exposures may be limited to surface water and sediments in Ponds 6 and 8 and the de-barker pond. Further, only open space visitors may contact this surface water or sediments during on-site recreational activities, such as wading in the pond.

At present, there are no plans for sampling sediments or water in the shoreline intertidal area along the western Site boundary. If, in the future, sampling is conducted in this area because of the potential for constituent releases, the potential for visitor exposure to COPCs in sediments or water in this area will also be examined.

In summary, based on currently available information, future on-site receptors could have potential COPC exposures through:

- Incidental ingestion of soil,
- Dermal contact with soil,
- Inhalation of airborne dust,
- Inhalation of vapors released from soil or groundwater,
- Incidental ingestion of sediment,
- Dermal contact with sediment,
- Dermal contact with surface water, and
- Ingestion of homegrown produce.

Each of these potential exposure pathways will be examined for those areas of the Site where COPCs are detected that could result in direct or indirect exposures. Also, the evaluation of groundwater as a potential drinking water resource will assume that there may be several complete exposure pathways including ingestion of groundwater, dermal contact with groundwater during bathing, and inhalation of vapors emitted from groundwater during showering. Sampling data available at the completion of the planned Site investigations and additional information on potential future Site uses will be used to refine the CSM and specify the potentially complete exposure pathways for the Site.

5.2.2 Quantitative Exposure Analyses

Chemical exposure is a result of the intake or uptake of a chemical from the environment. Each complete exposure pathway selected for quantitative analysis will be evaluated using pathway-specific models as described in USEPA (1989) guidance. Each exposure model conforms with the generalized exposure formula, as follows, and results in exposures normalized for time and body weight. Thus, exposures are expressed as the amount of a chemical taken into the body per unit body weight per unit time (i.e., mg/kg/day):

$$\text{Intake} = \frac{C \times CR \times EF \times ED}{BW \times AT}$$

where

C	=	Chemical concentration in environmental medium (e.g., mg/kg);
CR	=	Contact rate with environmental medium per unit time (e.g., mg/day);
EF	=	Exposure frequency (days/year);
ED	=	Exposure duration (years);
BW	=	Body weight (kg); and
AT	=	Averaging time for pathway-specific exposure period (days).

The values used for the different factors in the quantitative exposure assessment will be obtained from a combination of USEPA, DTSC, and site-specific determinations. A primary consideration will be the USEPA guidance that exposure variables be selected so that the combination of all intake variables results in an estimate of the reasonable maximum exposure (RME) for that pathway.

This generalized formula will be modified according to the factors necessary to evaluate each complete exposure pathway. Quantitative evaluation will depend on the concentration of chemical in each of the environmental media, the amount of environmental medium ingested, inhaled or dermally contacted, receptor body weight, and the frequency and duration of exposure.

Formulas for calculating exposures for soil/sediment ingestion, dermal contact with soil/sediment, inhalation of airborne dusts and vapors emitted from soils or groundwater, groundwater ingestion, dermal contact with groundwater/surface water, and inhalation of vapors emitted from groundwater used for potable purposes are provided in Tables 1 to 6. These formulas will be used to calculate risks depending on measured chemical concentrations in the environment.

The exposure parameters proposed for use in estimating exposures for three of the four groups of receptors are also shown in Tables 1 to 6. As shown, these parameters are based to the extent possible on USEPA and DTSC guidance with the parameters selected so that the combination of all intake variables results in an estimate of the reasonable maximum exposure (RME) for that pathway.

Since the USEPA has not defined a "default" recreational visitor scenario, other recreational scenario guidelines will be examined for applicability to this Site. For example, several different estimates of the exposure frequency for recreational receptors are available, such as the recommendations made by Oak Ridge National Laboratories (ORNL 2005) for recreational receptors that include an exposure frequency of 75 days per year. Other studies of recreational activities, such as hiking and photography in Idaho and hiking, bird watching, and photography in New Mexico (Burger 1999, 2000), will also be examined to estimate a potential range of frequency for open space visitor at this Site. These assumptions will be examined in more detail along with the any available documentation on the use of nearby recreational areas to estimate representative exposure parameters for open space visitors at the Site.

Generally, the concentration of a chemical in an environmental medium exhibits spatial variability. Furthermore, receptors may move within an area in which COPCs have been detected. Therefore, it is important to estimate the concentration of a COPC in a manner consistent with the location and route of potential human exposure. This estimate of chemical concentration is known as the exposure point concentration (EPC).

USEPA (1989, 1992b) guidance indicates that the maximum exposure concentration reasonably expected to occur at a site is best represented by the 95 percent upper confidence limit on the mean (UCL_{95}) or the maximum concentration, whichever is least. Calculation of a $UCL_{95,}$ however, is dependent on establishing a dataset with sufficient number of samples. For this Site, currently planned sampling density varies depending on the areas of interest where past operations occurred within each parcel. In a number of parcels sampling density is relatively low. Therefore, exposure evaluations for future on-site residents for an area comparable to a residential backyard (i.e., approximately 1000 square feet), as per OEHHA (2005) recommendations, may equate to use of the sampling results from one boring location. In contrast, sampling density is much higher in Parcels 3 and 5 and EPCs could potentially be based on estimates of the reasonable maximum chemical exposure concentrations (i.e., UCL_{95}) for specified areas of interest. Further, exposures to future industrial/commercial workers, construction workers, or open space visitors could occur over larger areas than assumed for future on-site residents. Thus, the specific approach for identifying samples to include in measures of exposure may need to be determined when all of the data are available. The specific approach selected for this evaluation will be discussed with the RWQCB-North Coast Region and OEHHA prior to evaluating exposures and estimating risks for future on-site receptors. For those areas and receptors evaluated using a RME-based exposure, each COPC will be examined to determine the distribution of the data and the UCL_{95} calculated using the latest version of ProUCL [USEPA 2004a], which follows USEPA [2002c] guidance.

Lead Exposure Analysis

Assuming that lead may be identified as a COPC in soil, the protocol used to assess potential health effects resulting from exposure to lead will be conducted in compliance with USEPA and California EPA guidance. Lead exposures will be evaluated in terms of potential blood lead (Pb) concentrations (micrograms [µg]-Pb per deciliter [dL]-blood). This is necessary because lead exposure is typically expressed in terms of blood-lead concentrations rather than as intake or absorbed doses (i.e., mg/kg-day). Potential lead exposure analyses will be carried out using spreadsheet applications developed by the State of California (DTSC 2000b) and the USEPA (2003b). The DTSC LeadSpreadsheet (v7) model will be used to predict blood-lead levels for future on-site residents (including children), while the Adult Lead Model (ALM) developed by the USEPA (2003b) will be used to evaluate future on-site workers. Both models integrate site-specific data on lead concentrations in soil, drinking water, air, and airborne dust levels and estimates the distributional pattern of blood-lead levels in potentially exposed receptors.

Airborne Chemical Exposures

The potential level of chemical exposure that may occur as a result of the inhalation exposure pathway is a function of the chemical concentration in airborne dust and/or vapors. The evaluation of the potential air migration pathway will include the following steps: 1) identification of COPCs, 2) characterization of the source of contamination, 3) delineation of potential migration pathways considering geologic, hydrologic, and meteorologic conditions, and 4) determination of COPC concentrations in the receiving environmental media (e.g., the atmosphere or indoor air).

- Step 1 is the identification of COPCs. This will include identifying the non-volatile COPCs in soil that may be emitted on airborne dust and the volatile chemicals detected in unsaturated soil (regardless of depth of detection) and groundwater.

- Under Step 2, the areal and vertical extent and delineation of the sources will be defined. The initial concentrations will be defined for each source area and will include, if appropriate, the reasonable maximum exposure (RME) concentration.

- Under Step 3, site-specific geologic, hydrologic, and meteorologic conditions pertinent to modeling will be analyzed. This will include information on physical soil data, such as porosity, moisture content, bulk density, that can be used in the modeling of dust or vapor emissions.

- Under Step 4, airborne dust and vapor concentrations will be calculated using either screening-level or more detailed models, as appropriate for the Site.

Particulate matter 10 microns (μm) or less in diameter (PM10) comprises respirable particles with an aerodynamic diameter less than 10 μm. It is anticipated that airborne dust (PM10) concentrations will be calculated using USEPA (2002) guidance for estimating particulate emission factors for undisturbed soils. These calculations will used to evaluate chemicals that sorb to soil particles (i.e., non-volatile chemicals) that could become airborne dusts through the erosion of surface soils by the wind. Exposure point concentrations will be calculated from the emission fluxes using an air dispersion factor, as defined by the USEPA (1996a, 1996b) or calculated using an air dispersion model, such as SCREEN3 (USEPA 1995), as appropriate.

Vapor emissions from soils will be addressed, as appropriate, by the USEPA's Volatilization Factor (VF) approach or other USEPA models, such as VLEACH, depending on chemical concentrations, soil types observed in the source areas, and the complexity of the source terms. For example, USEPA guidance recommends models such as VLEACH (version 2.2a; Ravi and Johnson 1996) to address vapor emissions from soil, when more accuracy is desired in defining the risk of exposure via inhalation and when migration to groundwater pathway is also considered. Thus, use of such a model will provide an integrated approach for considering both chemical migration to the atmosphere or groundwater, as necessary. Airborne vapor concentrations will be calculated using the same air dispersion analyses used to estimate airborne dust concentrations. USEPA models, such as VLEACH, will also be used to estimate vapor emissions from groundwater and subsequent transport to the atmosphere.

The Johnson and Ettinger indoor air models (USEPA, 2000b, 2000c), modified according to DTSC (2005) guidance will be used to calculate the intrusion and subsequent accumulation of chemical vapors in buildings from COPCs in subsurface soil and groundwater. The Johnson and Ettinger indoor air model is one of the models recommended in the *Air/Superfund National Technical Guidance Study Series on Assessing Potential Indoor Air Impacts for Superfund Sites* (USEPA, 1992b). The model incorporates both convective and diffusive mechanisms that drive vapor intrusion rates, and also accounts for subsurface soil and building properties.

Produce Consumption

In the future, fruits and vegetables may be grown at the Site in residential backyard gardens. Consumption of these products by on-site residents will be assumed to occur. For uptake of chemicals into edible plants, the USEPA (2005a) recommends an approach for evaluating the soil-plant-human exposure pathway. This evaluation includes estimation of COPC uptake by three types of produce: protected aboveground produce, unprotected aboveground produce, and below ground root vegetables. A highly health protective approach recommended by the USEPA (2005a) will also be followed, wherein it will be assumed that all of the fruits and vegetables eaten by residents will be from the Site. The same USEPA (2005a) guidance will be used to obtain soil-to-plant bioconcentration factors. This includes the use of elemental-specific bioconcentration factors (BCFs) for metals that were obtained primarily from Baes et al. (1984) and the use of BCFs for organic compounds calculated using the regression equation developed by Travis and Arms (1988). The proposed exposure parameters for on-site residential produce consumption are presented in Table 6.

5.3 Toxicity Assessment

The purpose of the toxicity assessment will be to evaluate the potential for COPCs to cause adverse health effects, either carcinogenic or noncarcinogenic. The toxicity assessment will consist primarily of the tabulation of critical toxicity values. Critical toxicity values (dose-response variables) used in quantitative risk assessments are cancer potency factors, or slope factors (SFs), for carcinogens and reference doses (RfDs) for noncarcinogens or noncarcinogenic endpoints of carcinogens. Toxicity values will be obtained from several primary sources, according to the following order of priority: (1) a listing of carcinogenic SFs developed by Cal EPA (2006) and provided online at http://www.oehha.org/risk/chemicalDB/index.asp and (2) toxicity values developed by the USEPA (2006) Integrated Risk Information System (IRIS) and provided online at http://www.epa.gov/iris/. Other sources will be identified in accordance with USEPA (2003) guidance, where appropriate. A preliminary set of toxicity values is provided in Appendix B, based on chemicals detected during past investigations of soil (TRC 2004b,c) and groundwater (TRC 2005; AME 2005c). These toxicity data will be reviewed and updated prior to estimating risks for the COPCs identified for this Site.

The RfDs used to evaluate the toxic effects of the petroleum hydrocarbon carbon-chain fractions will be based on the values recommended by the Total Petroleum Hydrocarbon Criteria Work Group (TPHCWG) (1997). Six TPH groups will be evaluated, based on the standard analytical TPH (8015M) method (i.e., carbon chain groups of >C6-C8, >C8-C10, >C10-C12, >C12-C16, >C16-C24, and >C24-C36). Since the laboratory will not report separate aromatic and aliphatic fractions for these carbon chain groups, a health-protective approach will be used to evaluate each group, based on the more toxic component of each carbon chain group, as defined by the TPHCWG (1997). The toxicity values identified using this approach are provided in Appendix B.

The USEPA has not developed an RfD for lead, primarily because there is considerable controversy regarding the threshold at which adverse health effects occur. The USEPA has determined that lead exposure can result in various health effects, depending on the level of exposure. Exposure to high doses of lead can cause coma, convulsions, and even death. Exposure to low levels of lead can cause harm gradually and imperceptibly, with no obvious symptoms. There is no known threshold for health effects from lead. However, health effects are not well substantiated for blood-lead concentrations below 10 micrograms per deciliter (µg/dl), while there is strong evidence for health effects with blood-lead concentrations of 10 to 15 µg/dl. Consequently, the USEPA and DTSC use 10 µg/dl as the blood-lead concentration of concern (Federal Register (FR) 66[4]:1206-1240; FR 63[106]:30316-30317]. Therefore, to evaluate potential health effects from exposures to lead, two computer spreadsheet models will be used to predict potential blood-lead levels for comparison with the blood-lead level of concern. The DTSC lead spreadsheet model (v7) will be used to predict blood-lead levels for future on-site residents (including children), while the Adult Lead Model (ALM) developed by the USEPA (2003b) will be used to evaluate future on-site workers.

5.4 Risk Characterization and Uncertainty Analysis

The risk characterization will integrate the exposure assessments and chemical toxicity information to produce quantitative estimates of potential health risks due to the COPCs. Risks will be determined for individual chemical parameters as well as for additive effects. The results of the risk characterization will provide a basis for decisions regarding whether further actions may need to be taken. Because of fundamental differences in the calculation of critical toxicity values, the estimates of potential excess carcinogenic risk probabilities and noncarcinogenic hazard indices will be calculated for each group of identified receptors. Also, as discussed in Section 5.2, depending on the approaches used to calculate exposures, risks may be presented using one of two separate approaches. For residents and other receptors evaluated on the basis of an area defined by a limited sample size (e.g., one boring per 1,000 square feet), risks may be presented using a risk per unit concentration approach and estimates of risk contoured across the Site. For those evaluations based on RME estimates, risk estimates will be presented in tabular format. Each set of evaluations will present risks estimated across chemicals and applicable exposure pathways.

In addition to the presentation of numerical risk estimates, the risk characterization will include an interpretation of the results and a qualitative evaluation of the uncertainties associated with the calculated risk estimates.

6. Ecological Risk Assessment

The ecological risk assessment will evaluate the potential for adverse ecological impacts that may occur as a result of possible chemical releases under baseline (i.e., current) conditions at the Site. The Site is located along the coast in Mendocino County, California. The approach for conducting the ecological risk assessment is consistent with all applicable California and Federal guidance documents. The predictive ecological risk assessment will consist of essential sub-tasks that are grouped into three main components:

- Problem Formulation;
- Analysis Phase; and
- Risk Characterization.

The problem formulation tasks are conducted to ensure that the exposure scenarios and biological receptors most likely to contribute to ecological risks are evaluated. Quantitative analyses of environmental data are conducted in the analysis phase. In the risk characterization phase, hazard quotients are calculated, sources of uncertainty are characterized, and the potential for and ecological significance of adverse ecological impacts are evaluated.

6.1 Problem Formulation

Problem formulation establishes the scope of the ecological risk assessment, identifies the major factors to be considered, and ensures that biological receptors likely to be exposed and exposure scenarios most likely to contribute to ecological risk are evaluated (DTSC 1996a,b; USEPA 1992). Problem formulation consists of the following components.

- Identify areas of concern;
- Identify habitats and ecological receptors of concern;
- Identify constituents of potential concern (COPCs);
- Identify potentially complete exposure pathways; and
- Establish assessment endpoints and measures of effect.

The Site has been divided into 10 parcels based on activities conducted and potential releases (Figure 6). Each of the 10 parcels is being evaluated for contamination. As described in the next section, several areas support viable habitat.

6.1.1 Habitats

Potentially affected habitats at the Site were evaluated by TRC (2003a) and WRA (2005a). Dominant wildlife habitat types on the Site include annual grassland, freshwater emergent wetland, and limited areas of red alder-dominated woodland (CDFG 2002; USDA 1997). Marine coastal habitat is present along the western edge of the Site.

There are multiple habitat classification schemes that could be used to define habitats for the ecological risk assessment. The definition of habitats is dependent on the manner in which the species being evaluated use and respond to the environment. For the purposes of this ecological risk assessment, we will use the habitat definitions provided in the California Wildlife Habitats Relationship System (CWHRS) (CDFG 2002). However, WRA (2005 a,b,c) utilized the plant habitat definitions described in Holland (1986) with some additions to characterize unique habitats. The relationship between the CWHRS and Holland classification schemes is summarized below.

CWHRS (CDFG 2002)	Holland (1986)/WRA (2005a)
Annual Grassland (AGS)*	Non-native Grassland Developed Industrial Coastal Terrace Prairie
Fresh Emergent Wetland (FEW)*	Coastal and Valley Freshwater Marsh
Wet Meadow (WTM)	Freshwater Seep Seasonal Wetland Seasonal Wetland Ditch
Valley Foothill Riparian (VFR)	North Coast Riparian Scrub Riparian Wetland
Coastal Scrub (CSC)	Northern Coastal Bluff Scrub
Marine (MAR)*	Coastal Strand
undefined	Planted Coniferous Woodland

* Dominant habitat type present on the Site

Based on observations at the Site, five major areas of potential wildlife habitat were identified. These areas are discussed below.

6.1.1.1 Industrial Ponds

Industrial ponds provide habitat for wetland and aquatic vegetation. Dominant vegetation along the banks of the ponds included California blackberry (*Rubus ursinus*), pampas grass (*Cortaderia jubata*), common rush (*Juncus effuses*), non-native grasses, and ruderal species such as skunk cabbage (*Lysichiton americanum*). Cattail (*Typha* sp.) dominated the shallow water depths (less than two feet) of Ponds 3, 5, and 8. An invasive water-milfoil species known as parrot's feather (*Myriophyllum aquaticum*) dominates large portions of the deeper water areas of Ponds 2, 3, 5, 6, and 8 covering up to 95 percent of the water's surface in some areas (TRC 2003a).

The ponds provide habitat for amphibians; invertebrates; and nesting, foraging, and roosting habitat for a variety of avian species. Species observed using the ponds on March 13, 2003 by TRC (2003a) included:

- Red-winged blackbird (*Agelaius phoeniceus*)—several breeding pair on Pond 8;
- Mallard (*Anus platyrhynchos*)—several breeding pair on Pond 8;
- American coots (*Fulica americana*)—several breeding pair on Pond 8;
- Great egret (*Ardea alba*)--single bird foraging on Pond 8;
- Belted kingfisher (*Ceryle alcyon*)—pair foraging on Pond 8;
- Ring-necked duck (*Aythya collaris*)—six breeding pair foraging on Pond 8; and
- Canada goose (*Branta canadensis*)—over 100 geese throughout the Site.

No threatened or endangered species have been observed within or near the industrial ponds. Ponds 6, 8, and the de-barker pond have been identified as potential jurisdictional wetlands (WRA 2005c).

6.1.1.2 Nursery Area (Parcel 9)

Vegetatation surrounding the nursery area is dominated by native and non-native grasses, redwood (*Sequoia sempervirens*), Douglas fir (*Pseudotsuga menziesii*), bluegum eucalyptus (*Eucalyptus globulus*) and Pacific yew (*Taxus brevifolia*).

The vegetation north of the nursery area where the city storm drains cross under Highway 1 to Pond 8 is riparian dominated by the Red Alder Series including red alder (*Alnus rubra*), arroyo willow (*Salix lasiolepis*), grand fir (*Abeis grandis*), native and non-native grasses, and a large population of pampas grass. This area has been identified as a potential jurisdictional riparian wetland (WRA 2005c).

6.1.1.3 Wetland Area North of the Power Plant (Parcel 4)

Stormwater from the northern portion of the Site flows through a system of pipes and discharges along the northern edge of the power plant, and has created conditions conducive to growth of wetland vegetation (TRC 2003a; WRA 2005c). The dominant vegetation in this area includes pampas grass, common rush, cattail, coastal wood fern (*Dryopteris arguta*), haircap moss (*Poltrichum juniperinum*), Coulter's lupine (*Lupinus sparsiflorus*), coarse cyperus (*Cyperus ferax*), and sword leaved rush (*Juncus eusifolius*). The wetland extends toward the former power plant. This area has been identified as a potential jurisdictional wetland (WRA 2005c).

6.1.1.4 Soldier Bay Beach (Parcel 4)

The beach is adjacent to the western edge of the property in the vicinity of the power plant. The eastern (landward) margin of the beach is riprapped with concrete and rock that supports a north-south road. Along the eastern side of the road lies Pond 6. A small grove of 6-8 eucalyptus trees borders the northern end of the beach. An unidentified hawk was observed roosting in this grove but no nest was observed (TRC 2003a). The overflow from the dam of Pond 8 (Log Pond) flows to the sea along the southern edge of the beach. Four stormwater drainpipes terminate at the beach, and appear to drain from the direction of the sawmill. Only two were flowing at the northern end of the beach during a steady rainstorm on March 13, 2003.

Several species of waterfowl have been observed on the beach including black oystercatcher (*Haematopus bachmani*), black-bellied plover (*Pluvialis squatarola*), sanderlings (*Calidris alba*), and several small plover species (*Charandrius* sp.). The federally threatened western snowy plover (*Charadrius alexandrinus nivosus*) was not observed on this beach in March 2003 (TRC 2003a).

6.1.1.5 South Edge of Property (Parcel 10)

The area south of the Log Deck and west of the airstrip is dominated by non-native grasses. This area provides foraging habitat for large numbers of Canada geese and deer. The ocean cliffs and those along Noyo Bay provide habitat for native vegetation and native wildlife including gulls (*Larus* sp.), terns (*Sterna* sp.), and several species of sparrow.

A canyon leading to Noyo Bay may potentially drain the southern end of the Site. The canyon is dominated by California blackberry, pampas grass, and hooker willow (*Salix hookeriana*) (TRC 2003a). This area has been identified as a potential jurisdictional riparian wetland by WRA (2005c).

6.1.2 Receptors of Concern

Given the number of species and the complexity of biological communities, all species present at the Site cannot be individually assessed. Receptors of concern will be identified for each parcel to (1) focus the ecological risk assessment on those receptors of regulatory, ecological, and recreational concern. Receptors of concern are identified for each potentially affected habitat present on the Site (see Section 2.1.1).

WRA's (2005a) biological assessment included identification plant species at the Site. A list of all plant species observed at the Site is provided in Appendix D.

A list of all vertebrate species that potentially use the annual grassland, fresh emergent wetland, and coastal marine habitats was developed from the California Department of Fish and Game "California Wildlife Habitats Relationship System" computer program (CDFG 2002). This program allows specification of the habitats present and the general location of the habitats. In order to provide a comprehensive species list, habitat quality was not considered in selecting species. This list of species and their expected timing of habitat usage is provided in Appendix D. A key aspect of ecological risk assessment approach is to organize ecological receptors into guilds of taxonomically and trophicly related species. Conceptual food webs for the annual grassland and fresh emergent wetland habitats are shown in Figures 7 and 8.

6.1.2.1 Receptors of Regulatory Concern

Receptors of regulatory concern are defined as special status species and include the following categories of listed species:

- Federal and California listed threatened and endangered species;
- Federal and California listed candidate species;
- California fully protected species;
- California species of special concern.

Plant Species

Forty-seven special status plant species have been have been reported from the region. Of these, 18 plant species have a moderate to high potential to occur on the Site (Table 7). WRA (2005a) has confirmed the presence of three sensitive plant species: Blasdale's bent grass (*Agrostis blasdalei*), Mendocino coast Indian paintbrush (*Castilleja mendocinensis*), and short-leaved evax (*Hesperevax sparsifloia* var. *brevifolia*). A detailed list of other sensitive plant species that may potentially occur at the Site is provided in Appendix D of the Biological Assessment (WRA 2005a).

Habitat for Mendocino Coast Indian paintbrush (*Castilleja mendocinensis*), a California Native Plant Society (CNPS) list 1B species, lies predominantly along the southern and western margins of the property within and adjacent to the coastal cliffs. This species has been observed at "Glass Beaches" 1, 2, and 3, and on the cliff faces of Parcel 10 (WRA 2005a). Blasdale's bent grass (*Agrostis blasdalei*) , a CNPS list 1B species, is known from two small populations in Mac Kerricher State Park and from Navarro Point. This species was observed on Glass Beach 3 in Parcel 1 (WRA 2005a). The short-leaved evax (*Hesperevax sparsifloia* var. *brevifolia*), a CNPS list 2 species, was likewise observed on Glass Beach 3 and along the edge of Glass Beach 2.

Wildlife species

Sixty-three special status wildlife species have been have been reported from the region. Of these, 12 species have a moderate to high potential to occur on the Site (Table 7; WRA 2005a). Only one special status wildlife species, the osprey (*Pandion haliaetus*), has been observed at the Site. Although great blue heron (*Ardea herodias*) were observed at the Site, no evidence of rookery sites was found.

6.1.2.2 Receptors of Ecological Concern

Receptors of ecological concern were defined as ecological components mediating processes or interactions that affect the structure and function of existing habitats, communities, or ecosystems (e.g., key members of the system's food web). All trophic levels, including primary producers, are considered. Plants and animals that provide shelter and/or food for special status species were also considered when identifying receptors of ecological concern.

A key strategy to focus the ecological risk assessment is to organize receptors of ecological concern into guilds of taxonomically and ecologically similar organisms. Members of guilds considered to play a major role in maintaining the structure and/or function of identified habitats will be identified as receptors of ecological concern. No fish species are known, or are likely to, occur in any of the industrial ponds or other drainages on the Site. Receptors of ecological concern are likely to include members of the following guilds:

- Plants, including grasses and forbs, shrubs, and trees;
- Soil invertebrates;
- Aquatic invertebrates;
- Sediment invertebrates;
- Amphibians;
- Reptiles;
- Resident herbivorous, insectivorous, and carnivorous birds; and
- Herbivorous, insectivorous, and carnivorous mammals.

6.1.2.3 Receptors of Recreational Concern

Receptors of recreational concern were defined as ecological components having a sporting or aesthetic value and include, but are not limited to, game and birding species. Receptors of recreational concern may include mule deer, while birding species may include species such as the osprey and pigeon guillemot.

6.1.3 Constituents of Potential Concern (COPCs)

Constituents of potential concern (COPCs) are detected constituents that may adversely affect receptors of concern. In this ecological risk assessment, COPCs present in soils, surface water, and groundwater will be used to evaluate exposures to plants, soil and aquatic invertebrates, and terrestrial wildlife. Groundwater is typically found at depths of less than 10 feet bgs due to the shallow bedrock present throughout the site. Permanent surface water is present in the eight ponds located on the site.

Media of concern are media that are accessible and are likely to be contacted by receptors of concern at a particular site or site cluster. Media of concern that will be addressed in this ecological risk assessment include:

- Shallow groundwater that is accessible to root systems (groundwater less than 5 feet bgs);
- Surface water that is accessible to aquatic and terrestrial biota;
- Sediments that are accessible to sediment-associated biota (aerobic surface [less than 0.5 foot bgs] sediments);
- Soils that are accessible to terrestrial plants and wildlife (soils 0 to 5 feet bgs); and
- Air in underground burrows (assessed for burrowing animals only; 0 to 5 feet bgs).

Media that are not accessible to biota will not be screened for COPCs.

6.1.3.1 Soil

For the purposes of this ecological risk assessment, soils will be evaluated using two depth intervals: 0 to 2 feet bgs, and 0 to 5 feet bgs. Plants will be assumed to be exposed to different soil depth intervals depending on the depth of their root systems (Schenk and Jackson 2002); similarly, wildlife are likely to be exposed to different soil depth intervals based on their behaviors. Therefore, accessible soils are delineated into soil depth intervals to more accurately characterize chemicals that receptors of concern may contact. For the most part, burrowing animals do not burrow deeper than 5 feet bgs and most grasses and shrubs have the majority of their root systems within the top 2 feet of soil (Schenk and Jackson 2002). Tree roots are likely to penetrate to 5 feet bgs.

In each soil depth interval, potentially contaminated Site samples will be compared to the background data sets as described in Section 4. All metals elevated above background will be carried forward into the risk assessment. All organic compounds meeting QA/QC criteria will be retained in the ecological risk assessment.

6.1.3.2 Sediments

No background data sets are currently available for pond sediments in the Site vicinity, nor are any data available from Site sediments. However, the Site receives municipal surface water runoff from upgradient areas in the City of Fort Bragg that is likely to carry potentially contaminated sediments. When sediment data become available, they will be evaluated to determine whether soil background concentrations or sediment background concentrations could be used to identify metals as COPCs. All organic compounds meeting QA/QC criteria will be considered as COPCs. As appropriate, offsite contributions to identified risks will be evaluated.

6.1.3.3 Surface Water

No background data sets are currently available for surface waters in the Site vicinity. However, the Site receives municipal surface water runoff from upgradient areas in the City of Fort Bragg. Data from offsite surface water sources, if available, will be considered when selecting COPCs for inclusion in the ecological risk assessment.

6.1.3.4 Groundwater

Groundwater enters the Site from upgradient areas in the City of Fort Bragg. Water quality data from groundwater wells located along the perimeter of the Site, and likely to be unimpacted by Site activities, will be used to evaluate concentrations of COPCs entering the Site in groundwater. Monitoring wells installed by TRC (2004b) were sampled quarterly in 2004 and 2005. Additional wells are being installed during the current investigation and the analytical results from these wells will be evaluated in determining the COPCs in groundwater. As discussed in Section 4, metals concentration data from these wells will be used, if available, to identify metal COPCs. All organic compounds present in groundwater and meeting QA/QC criteria will be considered in the identification of COPCs. This evaluation will also consider the potential influence of upgradient sources of certain organic compounds, such as MTBE from gasoline releases at nearby gas stations. As appropriate, offsite contributions to identified risks will be evaluated.

6.1.4 Potentially Complete Exposure Pathways

Identification of complete exposure pathways focuses the ecological risk assessment on those exposure scenarios that are most likely to put receptors of concern at risk. Potentially complete exposure pathways consist of:

- A source and mechanism of constituent release;
- A transport medium (e.g., soil, water, tissue);
- A point or area where receptors of concern may contact constituents; and
- An exposure route through which constituent uptake occurs (e.g., ingestion).

A preliminary Conceptual Site Model (CSM) for the ecological risk assessment has been developed for the Site based on data presently available (Figure 6). The CSM identifies and summarizes the sources, mechanisms of transport, media of concern, exposure routes, and receptor groups. Exposure routes that will be considered in this ecological risk assessment are expected to include:

- Bioaccumulation of constituents from soil and groundwater by grasses and forbs, shrubs, and trees;
- Bioaccumulation of constituents in soil by soil invertebrates;
- Bioaccumulation of constituents in sediment by sediment invertebrates;
- Bioaccumulation of constituents in water by aquatic invertebrates;
- Incidental ingestion of constituents in soil by wildlife; and
- Ingestion of COPCs in food items (i.e., plant, invertebrate, or wildlife tissues) by terrestrial wildlife.

Inhalation of volatile COPCs in subsurface soils will be evaluated only for burrowing wildlife because these animals may spend a significant portion of their life in the confined air spaces of their burrows and may be exposed to volatile COPCs in subsurface soils. Volatile COPC concentrations in burrows will be estimated using equilibrium partitioning between adsorbed, water, and soil gas phases. Similarly, inhalation of volatile COPCs is considered to be an insignificant exposure pathway for surface dwelling receptors of concern because:

- Concentrations of volatile chemicals released from soil to aboveground air are drastically reduced, even near the soil surface (USACE 1996); and
- VOC concentrations in soils would have to be high in order to induce effects in wildlife based on consideration of inhalation toxicity data for laboratory rats and mice (USACE 1996).

Dermal absorption of COPCs will not be considered as an exposure pathway for identified wildlife receptors of concern. Exposures via dermal contact are often of limited consequence as most exposure for mammals is from soil and food ingestion.

Surface water from the log pond (Pond 8) discharges to the intertidal beach over a small dam. This water rapidly flows over a limited width of intertidal sands and gravels to Soldier Bay. Upon reaching the marine waters, the fresh surface waters from the log pond are substantially diluted. Exposures to intertidal and subtidal marine organisms are considered potentially incomplete. Therefore, risks to marine invertebrates and fish are likely to be minimal. Depending on the results of the ecological risk assessment, exposures to marine organisms may be considered at a later stage.

6.1.5 Assessment Endpoints

Assessment endpoints are explicit expressions of the actual environmental value that is to be protected, operationally defined by an ecological entity and its attributes (USEPA, 1998). Assessment endpoints are selected to address adverse effects to ecological receptors, including individuals of sensitive species. Assessment endpoints link the risk assessment to management concerns and are comprised of two elements: (1) the entity of concern and (2) the characteristics of the entity that are important to protect and are potentially at risk (USEPA 1996). USEPA (1998) guidance recommends that assessment endpoints should be established based on ecological relevance and management goals.

Assessment endpoints will be established to protect populations of plants, invertebrates, and wildlife receptors. Assessment endpoint statements for receptors of regulatory concern will be established to ensure protection at the level of the individual, whereas assessment endpoint statements for other receptors will be established to ensure protection at the level of the population.

Measurement endpoints define measurable changes in an attribute of an assessment endpoint in response to a stressor to which it is exposed are termed. Measures of effect may include evidence of chronic effects such as reproductive, morphological, or physiological impairment in representative species.

The primary measures of effect used in the ecological risk assessment will include toxicity data associated with chronic reproductive or developmental impairment. A set of toxicity profiles will be prepared for those COPCs contributing significantly to the risk assessment. These profiles will include information about biological effects of each COPC, including acute and chronic toxicities. References will be included that identify documents where more detailed toxicity descriptions can be found.

6.2 Analysis Phase

During the analysis phase, technical evaluation of data on potential exposure and effects is conducted. This includes introduction of the indicator species, the quantification of exposure, and the comparison the exposure results to toxicological benchmarks.

6.2.1 Indicator Species

Given the number of species and the complexity of biological communities, each species present at or near the Site can not be individually assessed. Rather, indicator species that are representative of those likely to be found at the Site will be used to develop screening criteria. In the ecological risk assessment, risks will be evaluated for a representative set of indicator species in each parcel or habitat. Risks to indicator species are subsequently used to infer the potential for adverse impacts to taxonomically and functionally related receptors of concern. The selection of plant, invertebrate, and wildlife receptors of concern as described here is consistent with State and Federal guidance (DTSC 1996a).

To identify indicator species, receptors of concern are organized into guilds of ecologically and taxonomically related organisms. Indicator species will be selected for each guild to represent receptors of concern based on:

- Taxonomic relatedness to receptors of concern;
- Similar function or role in the ecosystem;
- Species representative of entire guilds;
- Known or presumed similarities in physiology and life history;
- Availability of wildlife exposure factor data (e.g., ingestion rates);
- Species for which completed exposure pathways can be developed;
- Species considered sensitive or of special status by federal or state regulatory agencies or that can be considered surrogates for such species;
- Species considered essential to or indicative of normal functioning ecosystems;
- Biological characteristics that would tend to maximize estimates of exposure (e.g., small body size, small home or foraging ranges, forages on ground surface);
- Minimizing extrapolation of existing toxicity data (to the degree possible); and
- Presence in a variety of on-site habitats to streamline the assessment effort.

A food web based approach is proposed to address the major exposures from direct contact with contaminated sources as well as the potential bioaccumulation of contaminants throughout the food chain. Using the food web structure as the basic outline for the indicator species selection process, indicator species will be selected from the list of species potentially present at the Site for each of the following ecological guilds (Table 8):

- Plants;
- Soil invertebrates;
- Sediment/aquatic invertebrates;
- Herbivorous small mammals;
- Insectivorous small mammals;
- Herbivorous birds;
- Insectivorous birds;
- Carnivorous birds; and
- Carnivorous mammals.

6.2.2 Exposure Assessment

Exposure pathways include migration pathways (i.e., fate and transport of chemicals) and exposure routes (Figure 6). Exposure routes are mechanisms through which plants and animals may take up COPCs from environmental media of concern.

To evaluate ecological risks, it is necessary to estimate exposures of COPCs to selected plant, invertebrate, and wildlife indicator species. Five essential inputs are needed to estimate exposures:

- Exposure equations;
- Exposure point concentrations;
- Wildlife exposure factors;
- Site presence index; and
- Bioaccumulation factors.

Exposure equations will be used to calculate exposures to indicator species. To facilitate comparisons with available toxicity data, estimates of exposure for metals and organics will be reported in the following units:

- Exposure to plants and soil invertebrates (mg_{COPC}/kg_{soil});
- Exposure to sediment invertebrates ($mg_{COPC}/kg_{sediment}$);
- Exposure to aquatic invertebrates ($\mu g_{COPC}/L$); and
- Exposure to terrestrial wildlife ($mg_{COPC}/kg_{body\ wt}/day$).

Exposure equations are only needed for wildlife species. Estimates of exposure plants and soil, sediment, and aquatic invertebrates are in units of concentration and, therefore, do not require exposure equations. COPC exposures to wildlife indicator species are calculated using pathway-specific exposure equations of the form (DTSC 1996; U.S. EPA 1993):

$$Dose = \frac{C * CR * FC * AF}{BW}$$

where C is the concentration in the medium, CR is contact (or intake) rate, FC is the fraction of media contacted (e.g., diet proportions), AF is the assimilation factor (assumed to be 1), and BW is body weight of the indicator species. Equations will be used to estimate ingested metal exposures to wildlife receptors (Figure 9). These exposure equations are consistent with formulas provided in USEPA's (1993) *Wildlife Exposure Factors Handbook*.

The concentration of a constituent in an environmental medium that a receptor of concern is likely to contact is termed the exposure point concentration (EPC). In accordance with regulatory guidance, the lesser value of (1) the upper 95th percent confidence limit on the mean (UCL_{95}) or (2) the maximum measured concentration will be used to estimate the EPC (USEPA 1989a). Since sampling at the Site has focused on characterizing areas known or suspected to have received released constituents, the protocol for calculating EPCs is likely to result in conservative estimates of EPCs.

The EPCs in soil will be calculated for the surface (0-2 ft bgs), and deep (0-5 ft bgs) depth intervals. These depth intervals are used to define the region of the soil horizon where exposure is expected to occur for the receptor species evaluated in the ecological risk assessment. The soil depth intervals considered applicable to each receptor are listed in Table 9.

To estimate exposures due to ingestion, inhalation, and dermal contact, the following exposure factors are required:

- Food ingestion rates;
- Inhalation rates;
- Soil and food diet proportions;
- Foraging area or home range; and
- Body dimensions (i.e., weight, length, width, height).

To provide the most accurate assessment with the least amount of uncertainty, indicator species-specific data will be used when available. The USEPA's (1993) *Wildlife Exposure Factors Handbook* and the California Department of Fish and Game's *California's Wildlife* (Airola 1988; Mayer and Laudenslayer 1988; Zeiner et al. 1988, 1990a,b) will be used as sources of wildlife exposure factors. The primary literature was also reviewed during compilation of the wildlife exposure factors. When data for a selected indicator species is not available, data for a taxonomically related species having a similar feeding biology and size is used; if needed, metabolic adjustments are made. When no wildlife species-specific data is available, allometric regression equations provided in USEPA's *Wildlife Exposure Factors Handbook* (1993) are used. Applicable exposure factors for the selected indicator species are provided in Table 9.

The site presence index is the ratio of the area of concern to the foraging area of a given receptor and will be used to estimate the fraction of time that a receptor is likely to spend in a particular area.

COPC concentrations transferred up the food chain will be calculated using chemical-specific soil-to-plant, soil-to-soil invertebrate, and soil-to-small mammal bioaccumulation factors. To evaluate COPC exposures to herbivores due to the ingestion of plants, COPC concentrations in plants will be calculated from soil EPCs using chemical-specific soil-to-plant bioconcentration factors (BCFs). To be consistent with the human health risk assessment process, quantitative relationships between soil concentrations and plant tissue concentrations (i.e., BCFs) will be obtained from the literature using the following priority: (1) Baes et al. (1984), (2) Bechtel Jacobs 1998, and (3) Travis and Arms 1988.

Most of the bioaccumulation factors for invertebrates, birds, and mammals were derived from log-linear regression models provided in Sample et al. (1998a,b, 1999) and Bechtel Jacobs Company LLC (1998a,b). Log-linear regression models are recommended for use in ecological risk assessments because the available data indicate that bioaccumulation by soil invertebrates, and small mammals is non-linear, decreasing with increasing soil concentrations (Sample et al. 1998a,b; Bechtel Jacobs Company LLC 1998a,b). If log-linear regression models are not available for certain constituents, point estimate bioaccumulation factors (which assume that accumulation is linear across all soil concentrations) will be obtained from Baes et al. (1984).

Wide-ranging receptors, such as the mule deer and red-tailed hawk, may be exposed to constituents throughout the Site. For these species, the site presence index will be calculated as the total area of the Site divided by the far-ranging receptor's foraging area. To calculate exposures from prey, tissue concentrations in each prey species within each Parcel will be calculated, and an area-weighted average exposure concentration calculated. This approach implicitly assumes that the wide-ranging receptors feed primarily in the areas characterized by the sampling data. Since environmental samples are being collected in areas having the highest potential for contamination, this approach is considered protective of the wide-ranging receptors.

6.2.3 Toxicity Assessment

The effects assessment establishes concentrations in media or doses of COPCs that pose an unacceptable potential for adverse ecological effects to receptors of concern at the Site. The ecological risk assessment will use two levels of response to bracket the range of potential ecological effects.

The purpose of the ecological effects assessment is to identify and quantify adverse effects elicited by released chemicals and, where possible, to evaluate cause-and-effect relationships (USEPA 1992b). Baseline ecological risk assessments rely on toxicity data available in the literature or compiled databases. Generally, the results of the ecological effects assessment are expressed as reference toxicity values (TRVs), which are then compared to the results of the exposure assessment to estimate the potential for adverse ecological effects. Exposures greater than TRVs are considered to pose a potential for adverse impacts. Ideally, TRVs are concentrations or doses at which effects begin to occur and below which no effects are observed. However, there is variation between toxicological studies on the same chemical. In addition, there is disagreement as to which toxicological endpoint or response is appropriate. Therefore, one set of TRVs may not adequately protect ecological receptors.

The ecological effects assessment will follow the approach developed through extensive discussions between the U.S. Navy (Engineering Field Activity, West), U.S. EPA Region 9's Biological Technical Assistance Group (BTAG), and the California Department of Toxic Substances Control, amongst others (EFA West 1998). This Navy/BTAG approach utilizes two sets of TRVs, referred to as the TRV-Low and TRV-High, for each COPC. For the ingestion exposure pathway of mammals and birds, TRV-Lows and TRV-Highs are utilized to more accurately evaluate the range of potential impacts to wildlife receptors. TRVs for these receptors were obtained or derived primarily from regulatory-approved databases or compilation documents, including EFA West (1998); Sample et al. (1996); IRIS (USEPA 2005); Ecotox (USEPA 2004c); Rocketdyne (2003); and U.S. Air Force (2004a).

All TRV-Lows proposed for use in this risk assessment will be based on concentrations or doses that are not expected to produce adverse ecological effects. Media concentrations or doses at or below this level would not be expected to harm an individual or population of organisms. These values will be based on a chronic no observable adverse effect level (NOAEL). In other words, this would be the highest dose evaluated that did not result in a biological response in the test individuals. The TRV-Lows proposed for use in this risk assessment, including both the Navy/BTAG (EFA West 1998) and non-Navy/BTAG values, each represent the lowest credible chronic NOAEL.

The TRV-Highs proposed for use in this risk assessment fall into two groups. First, for all of the non-Navy/BTAG TRV-Highs, the derived value is based on a chronic lowest observable adverse effect level (LOAEL). The LOAEL is the lowest dose tested that resulted in a biological response in the test individuals. Second, all of the Navy/BTAG TRV-Highs represent a level at which some adverse effects may occur and lie approximately in the middle of the range of possible adverse effects (EFA West 1998). Thus the Navy/BTAG TRV-High is a value at which adverse effects have been demonstrated and are, therefore, not necessarily based on LOAELs.

6.2.3.1 Selected Responses

Reproductive and developmental responses are considered to be the ecologically relevant and sensitive test endpoints for evaluating impacts to ecological receptors at the Site. Reproductive impairment or developmental abnormalities are preferred because they can be directly related to assessment of individual fitness (i.e., the ability of individuals to leave viable offspring to the next generation) and the persistence of populations. Relevant study features that will be used to select among several germane reproductive or developmental studies include:

- Doses were administered during critical and sensitive periods (e.g., during gestation) and/or effects on sensitive life stage (e.g., effects on fetuses, embryos);

- Chronic exposures (> 50% of the life span) or doses were administered-through most of the reproductive period;

- Use of a serial dosing regime, especially a serial dosing regime in which both a NOAEL and LOAEL were reported;

- Large "per treatment" sample sizes were examined;

- Methods and results of statistical analyses were described; and

- Wildlife species were examined in the study.

If reproductive impairment or developmental abnormality data are not available, chronic toxicity data for growth, physiological (e.g., enzyme activity), systemic (e.g., organ weight), or behavioral responses will be used. These responses are not preferred because it is difficult to relate these responses to quantifiable decreases in reproductive success or the persistence of wildlife populations. When these types of responses are used, the effects of their use on the conclusions of the ecological risk assessment will be discussed.

Toxicity data for soil invertebrates (primarily earthworms, microbial communities, or soil invertebrate communities) are moderately available. Phytotoxicity data for plants are also moderately available. For plant TRVs, recent primary literature, Efroymson et al. (1997), and Kabata-Pendias and Pendias (1984) will each be considered as a source to develop phytotoxicity benchmarks.

Ambient water quality criteria will be used to assess risks to COPCs detected in surface water to aquatic invertebrates. The criterion selected will be the lower of (1) the USEPA (2004c) ambient water quality criteria, (2) criteria published in the California Toxics Rule (CTR) (USEPA 2000), or (3) objectives specified in the North Coast Regional Water Quality Control Board (NCRWQCB) Basin Plan (Basin Plan) (NCRWQCB 2001).

Concentrations of detected chemicals in freshwater sediments will be assessed using the Threshold Effects Level (TEL) or other relevant guidelines derived from benthic community studies and toxicity tests, as summarized in Buchmann (1999). The TEL represents the concentration below which adverse effects are expected to occur rarely, and therefore is protective of sediment quality. Sediment quality guidelines are also available in U.S. EPA (2005b), which provides an estimate of the probability of adverse effects given a known sediment concentration.

6.2.3.2 Chemical-specific Approaches

The toxicity of TPH will not be directly assessed for ecological receptors. The TPHCWG approach is not applicable to ecological receptors. The effects from exposures to TPH will be evaluated using the indicator chemicals present in environmental media. Dioxins and furans will be assessed using the TEF approach to scale exposures to 2,3,7,8-TCDD equivalent concentrations. Exposures to the 14 most toxic PCB congeners on the World Health Organization list will likewise be assessed using the TEF approach. The scaled exposures from dioxins/furans and the 14 PCB congeners will be compared to toxicity data for 2,3,7,8-TCDD.

6.2.3.3 Interspecific Scaling

Identified toxicity values based on test species, will be scaled using the approach defined by Sample and Arenal (1999), as currently supported by the DTSC. Metabolic rate is inversely proportional to body weight. Therefore, relative body weights can be used to scale reference doses between the test and receptor species. In general, the relationship takes the form:

$$RfD_{Receptor} = RfD_{TestSpp} \times \left(\frac{BW_{TestSpp}}{BW_{\mathrm{Re}ceptor}} \right)^{b}$$

The exponent “b” may take on a variety of values, based on the assumptions and data used to derive it. Sample and Arenal (1999) reviewed a large quantity of toxicological effects literature for birds and mammals for a wide range of toxicants, and developed taxon and chemical-specific scaling factors (i.e., values of “b”). Where chemical-specific allometric scaling factors are not available, default scaling factors for birds (1.2) and mammals (0.94) will be used (Sample and Arenal 1999).

6.2.3.4 Proposed TRVs

A list of proposed TRVs for each receptor class is provided in Appendix E. Additional TRVs will be developed as necessary.

6.3 Ecological Risk Characterization

Risk characterization integrates the results of the analysis phase (i.e., exposure and effects assessments) to evaluate the likelihood of adverse ecological impacts associated with exposure to COPCs (USEPA 1992c).

6.3.1 Estimate Risks

The hazard quotient (HQ) is the primary tool used to estimate the potential for adverse ecological impacts when sufficient exposure and toxicity data exist. An HQ is simply the ratio of the estimated exposure to the toxicity reference value (TRV):

$$Hazard\ Quotient\ (HQ) = \frac{Exposure}{TRV}$$

As suggested by existing guidance (USEPA 1996), cumulative effects will be evaluated only for those constituents having similar structures, having similar mechanisms of action, and producing similar adverse effects on the same target organ.

6.3.2 Identify and Characterize Sources of Uncertainty

The uncertainty analysis identifies the key assumptions and data gaps associated with the analyses performed. The approach that will be used for this ecological risk assessment is designed to mitigate sources of uncertainties that would result in underestimation of risks. Use of both a TRV-High and TRV-Low will provide a basis for bracketing the range of potential risks

The likely consequence of identified uncertainties on the conclusions of ecological risk will be discussed and recommendations for reducing known uncertainties will be presented.

6.3.3 Conduct Interpretation of Risks

As identified in current ecological risk assessment guidance (USEPA 1998), professional judgment plays a significant role in the interpretation of risk. HQs will be used to evaluate the potential for adverse ecological impacts. However, to support of the overall ecological risk assessment process, other factors to be considered when interpreting the ecological significance of potential risks include:

- Evaluation of the size and nature of potentially affected habitats;
- Consideration of the presence of threatened or endangered species; and
- Potential for recovery.

Consideration of these and other factors is intended to increase confidence in risk management decisions by using several different types of information in the decision making process.

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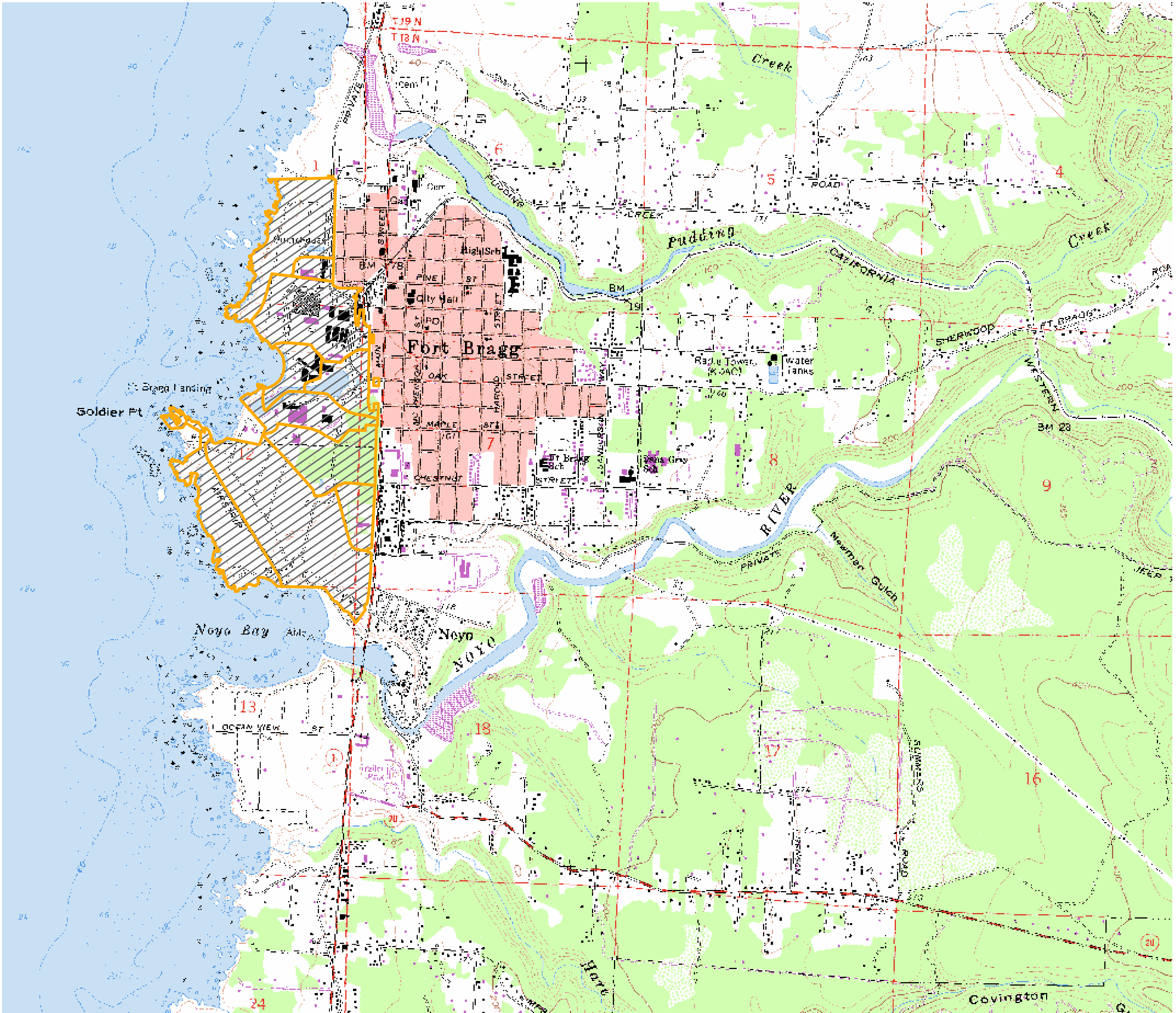


Legend

Site

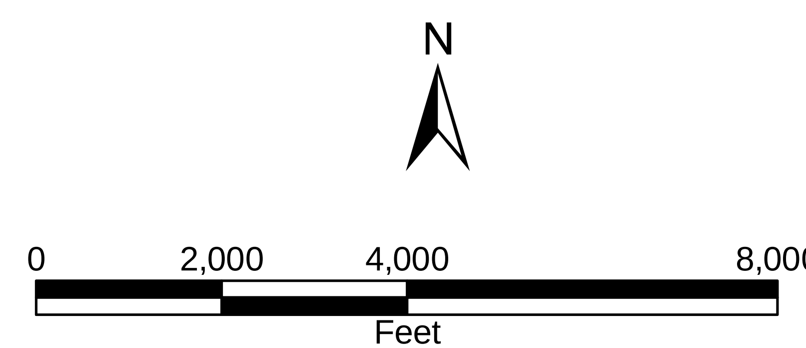


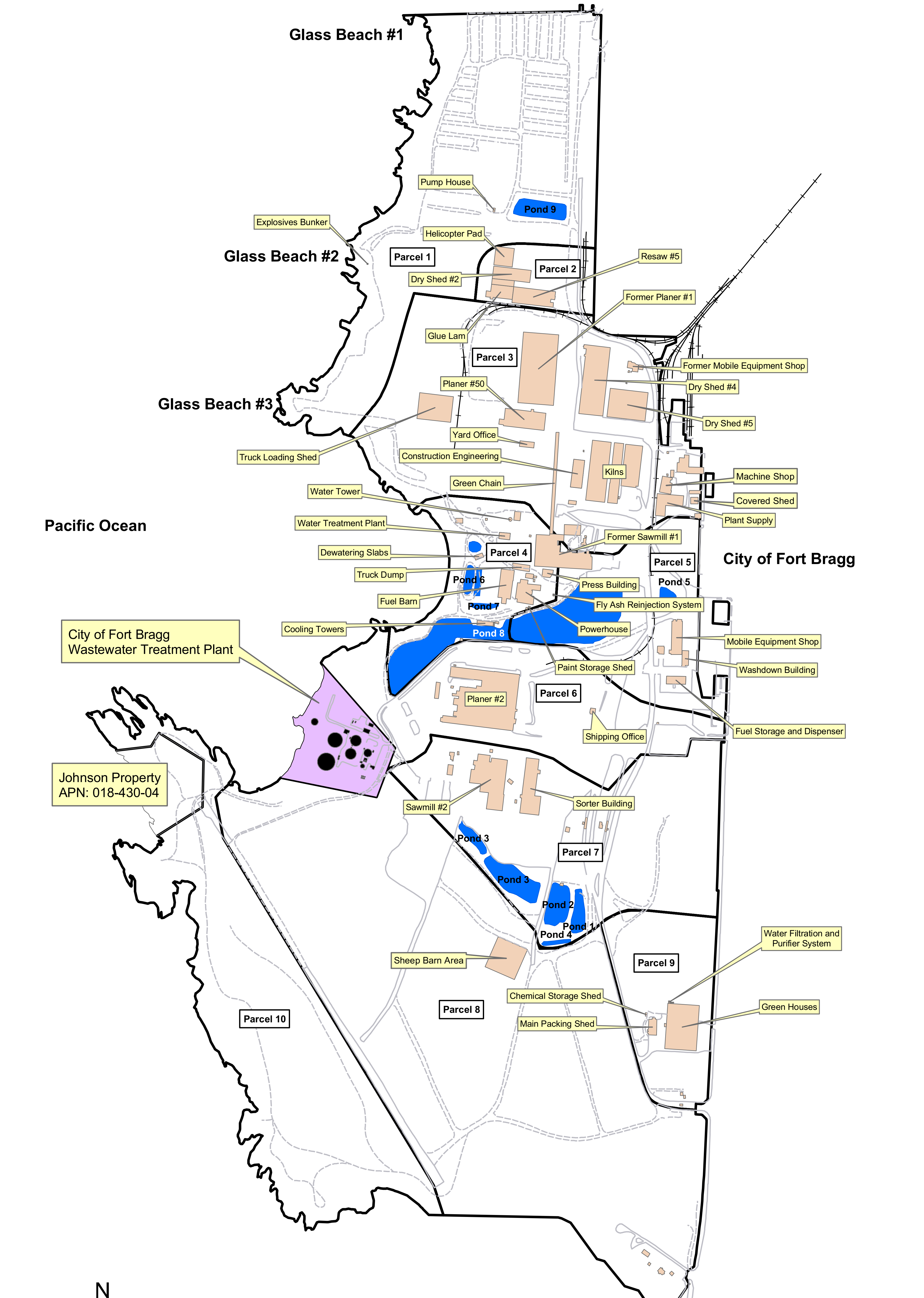
FIGURE 1

SITE LOCATION MAP

Georgia-Pacific California Wood Products Manufacturing Facility
90 West Redwood Avenue, Fort Bragg, California

Project No.	Drawn By
16017.01	AAC
Map File	Prepared By
1601701-017	MAA
	Reviewed By
Revison/Date	Scale
0 - 5/31/05	As Noted

Source material courtesy of:
Acton Mickelson Environmental, Inc.



N

Notes:
1. All locations and dimensions are approximate.

0 600 1,200 2,400
Feet

FIGURE 2

BUILDING LOCATIONS

Georgia-Pacific California Wood Products Manufacturing Facility
90 West Redwood Avenue, Fort Bragg, California

Project No.	Drawn By
16017.07	AAC
Map File: 1601707-011	Prepared By: JRH
	Reviewed By: JRH
Revison/Date: 0 - 6/1/05	Scale: As Noted

Source material courtesy of:
Acton Mickelson Environmental, Inc.

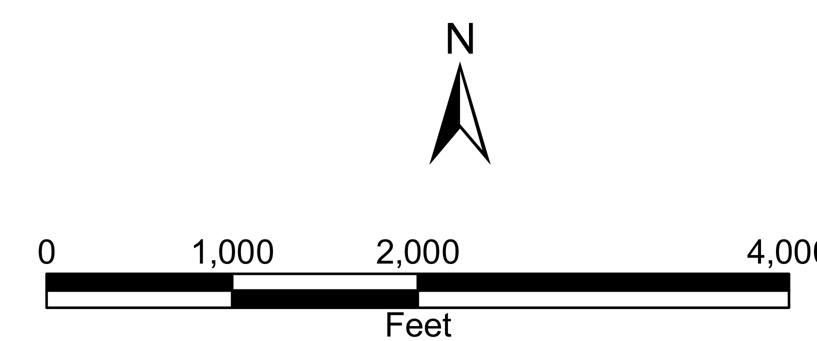


FIGURE 3

Parcel Locations

Georgia-Pacific California Wood Products Manufacturing Facility
90 West Redwood Avenue, Fort Bragg, California

Project No.	Drawn By	
16017.01	AAC	
Map File: sitemap	Prepared By: MAA	
	Reviewed By	Source material courtesy of:
Revison/Date: 0 - 3/7/05	Scale: As Noted	Acton Mickelson Environmental, Inc.

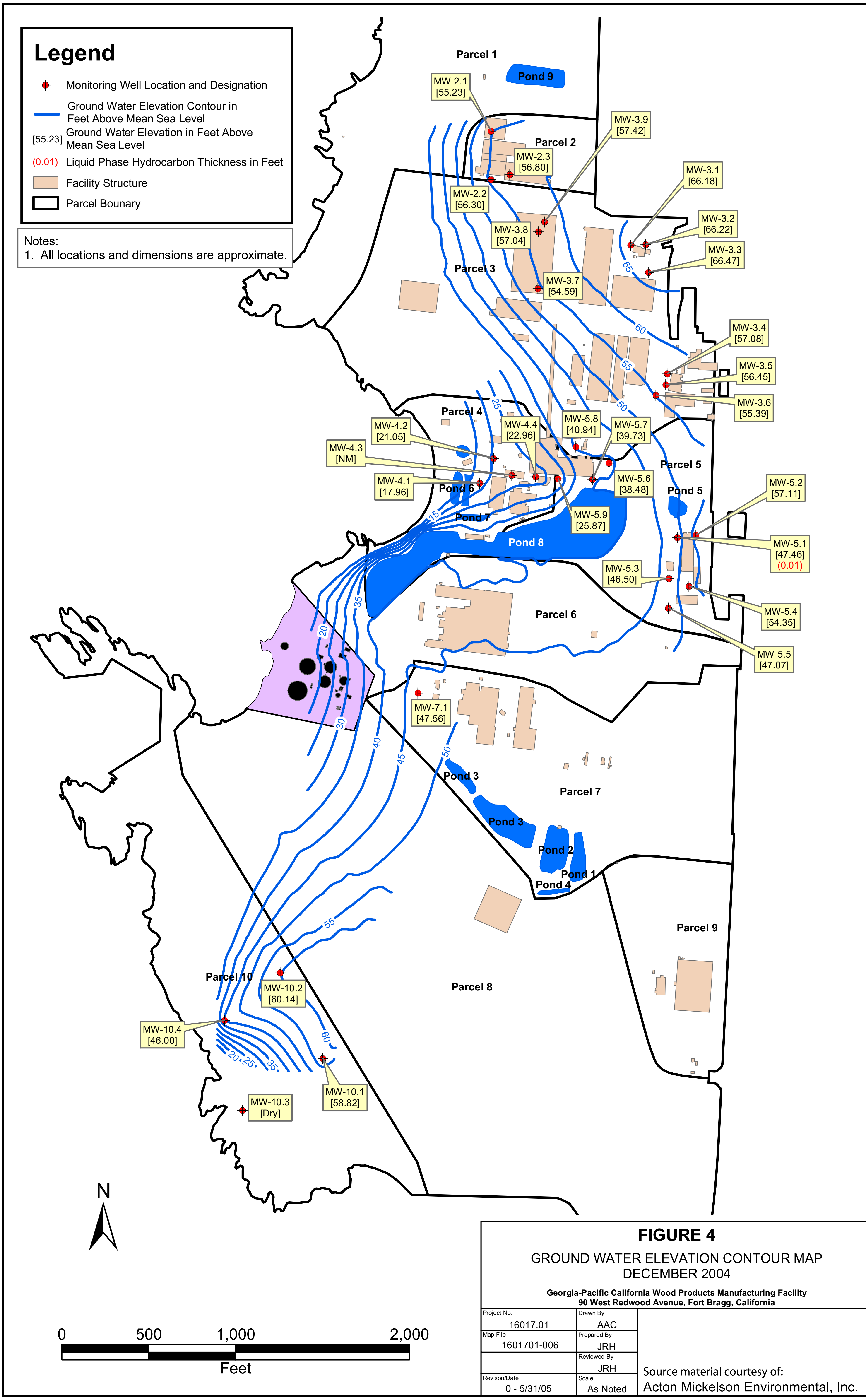


FIGURE 4

GROUND WATER ELEVATION CONTOUR MAP
DECEMBER 2004

Georgia-Pacific California Wood Products Manufacturing Facility
90 West Redwood Avenue, Fort Bragg, California

Project No.	Drawn By
16017.01	AAC
Map File: 1601701-006	Prepared By: JRH
	Reviewed By: JRH
Revison/Date: 0 - 5/31/05	Scale: As Noted

Source material courtesy of:
Acton Mickelson Environmental, Inc.

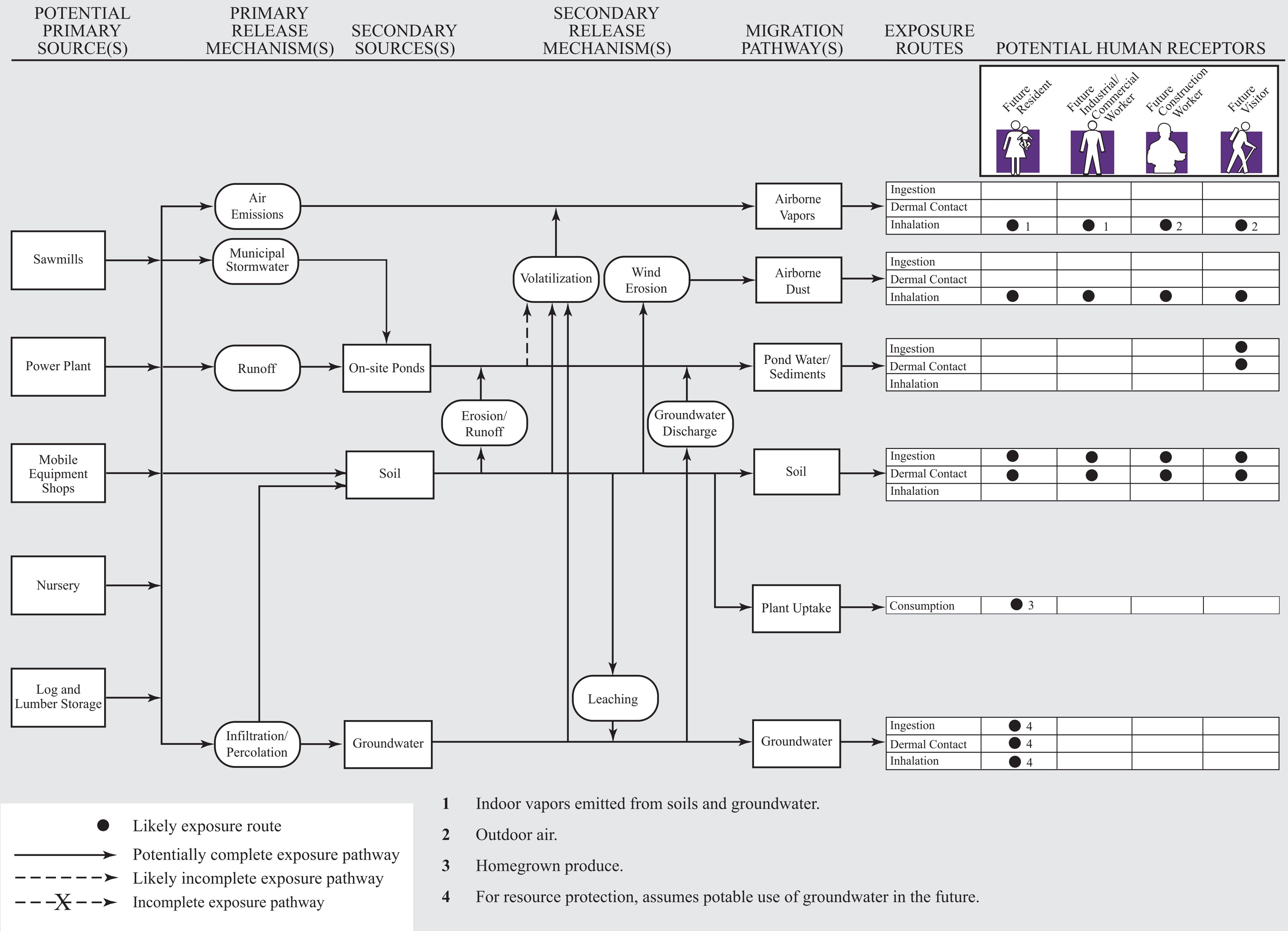


Figure 5

Conceptual Site Model for Human Receptors

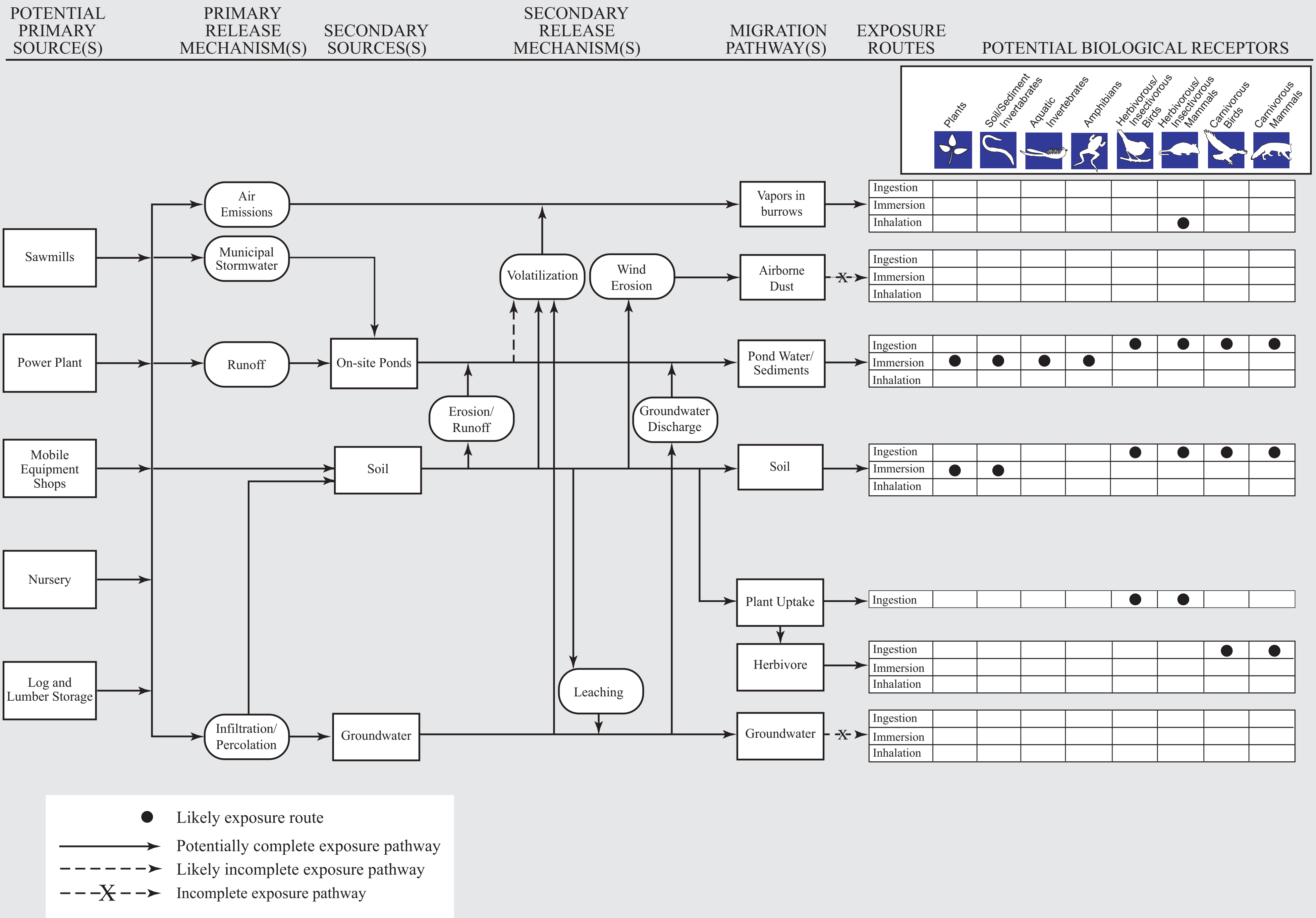


Figure 6

Conceptual Site Model for Ecological Exposures

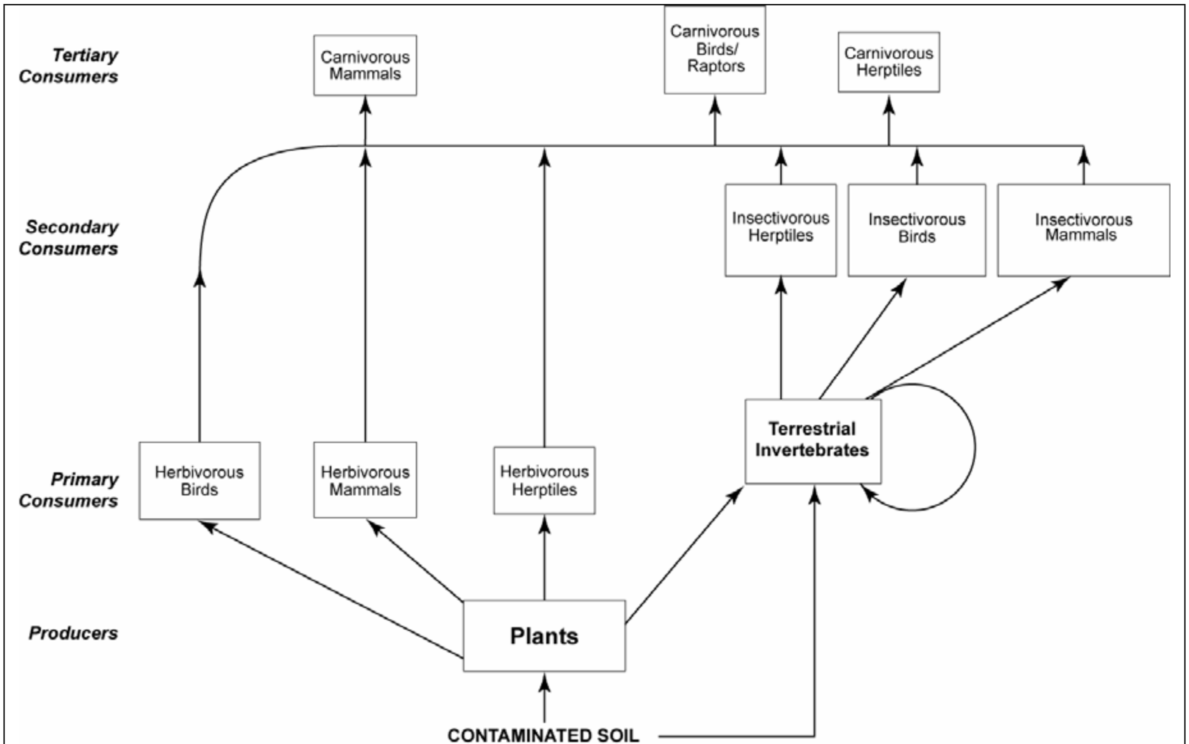


Figure 7. Food web for annual grassland (AGS) habitat.

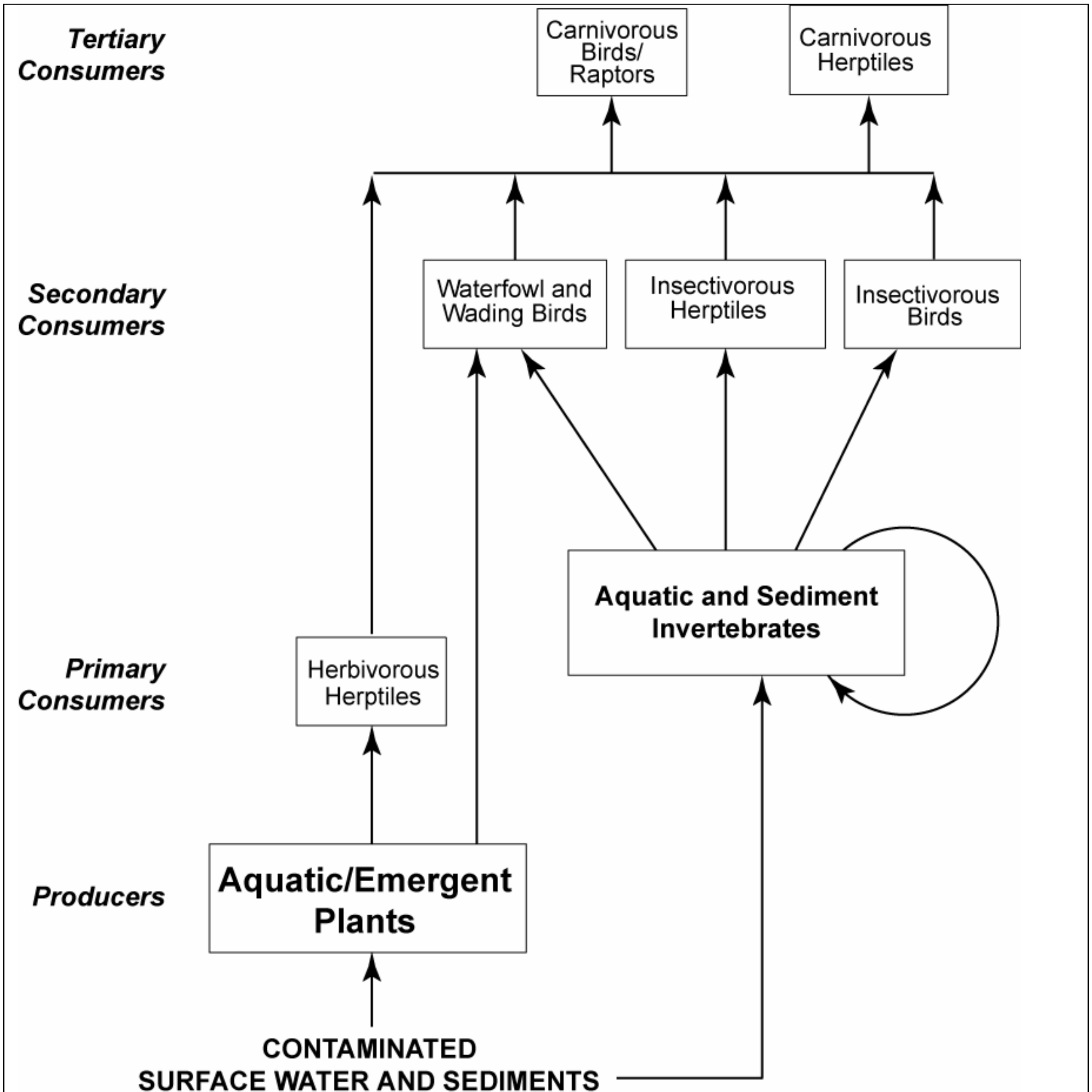


Figure 8. Food web for fresh emergent wetland (FEW) habitat.

Figure 9
Exposure Equations for
Ecological Receptors

TERRESTRIAL WILDLIFE

Herbivore

$$\text{Total Dose} = \text{Dose}_{\text{Drinking Water}} + \text{Dose}_{\text{Soil}} + \text{Dose}_{\text{Plant}}$$

$$\text{Dose}_{\text{Drinking Water}} = \text{DR} \bullet \text{C}_{\text{Water}} \bullet \text{SPI} \bullet \text{BW}^{-1}$$
$$\text{Dose}_{\text{Soil}} = \text{IR} \bullet \%\text{Diet}_{\text{Soil}} \bullet \text{C}_{\text{Soil}} \bullet \text{SPI} \bullet \text{BW}^{-1}$$
$$\text{Dose}_{\text{Plant}} = \text{IR} \bullet \%\text{Diet}_{\text{Plant}} \bullet \text{C}_{\text{Plant}} \bullet \text{SPI} \bullet \text{BW}^{-1}$$

where the concentration of C_{Plant} is determined from:

C_{Plant} = Literature-based BioConcentration Factor (BCFs), or
Literature-based regression model or median uptake factor (UF), or
Default uptake factor of 1. (see Figure 6.3-2 for selection precedence)

$$\therefore \text{Total Dose} = (\text{DR} \bullet \text{C}_{\text{Water}} \bullet \text{SPI} \bullet \text{BW}^{-1}) + (\text{IR} \bullet \text{SPI} \bullet \text{BW}^{-1} \bullet (\%\text{Diet}_{\text{Soil}} \bullet \text{C}_{\text{Soil}}) + (\%\text{Diet}_{\text{Plant}} \bullet \text{C}_{\text{Plant}}))$$

Insectivore

$$\text{Total Dose} = \text{Dose}_{\text{Drinking Water}} + \text{Dose}_{\text{Soil}} + \text{Dose}_{\text{Invert}}$$

$$\text{Dose}_{\text{Drinking Water}} = \text{DR} \bullet \text{C}_{\text{Water}} \bullet \text{SPI} \bullet \text{BW}^{-1}$$
$$\text{Dose}_{\text{Soil}} = \text{IR} \bullet \%\text{Diet}_{\text{Soil}} \bullet \text{C}_{\text{Soil}} \bullet \text{SPI} \bullet \text{BW}^{-1}$$
$$\text{Dose}_{\text{Invert}} = \text{IR} \bullet \%\text{Diet}_{\text{Invert}} \bullet \text{C}_{\text{Invert}} \bullet \text{SPI} \bullet \text{BW}^{-1}$$

where the concentration of C_{Invert} is determined from:

C_{Invert} = Literature-based regression model or median uptake factor (UF), or
Literature-based BioConcentration Factor (BCF), or
Default uptake factor of 1.

$$\therefore \text{Total Dose} = (\text{DR} \bullet \text{C}_{\text{Water}} \bullet \text{SPI} \bullet \text{BW}^{-1}) + (\text{IR} \bullet \text{SPI} \bullet \text{BW}^{-1} \bullet (\%\text{Diet}_{\text{Soil}} \bullet \text{C}_{\text{Soil}}) + (\%\text{Diet}_{\text{Invert}} \bullet \text{C}_{\text{Invert}}))$$

Figure 9 (continued)
Exposure Equations for
Ecological Receptors

Carnivore

$$\text{Total Dose} = \text{Dose}_{\text{Drinking Water}} + \text{Dose}_{\text{Soil}} + \text{Dose}_{\text{Prey}}$$

$$\text{Dose}_{\text{Drinking Water}} = DR \bullet C_{\text{Water}} \bullet SPI \bullet BW^{-1}$$

$$\text{Dose}_{\text{Soil}} = IR \bullet \%\text{Diet}_{\text{Soil}} \bullet C_{\text{Soil}} \bullet SPI \bullet BW^{-1}$$

$$\text{Dose}_{\text{Prey}} = IR \bullet \%\text{Diet}_{\text{Prey}} \bullet C_{\text{Small Mammal}} \bullet SPI \bullet BW^{-1}$$

where the concentration of $C_{\text{Small Mammal}}$ is determined from:

$C_{\text{Small Mammal}}$ = Literature-based regression model or median uptake factor (UF), or
Literature-based BioTransfer Factor (BTF), or
Default uptake factor of 1.

$$\therefore \text{Total Dose} = (DR \bullet C_{\text{Water}} \bullet BW^{-1}) + (IR \bullet BW^{-1} \bullet (\%\text{Diet}_{\text{Soil}} \bullet C_{\text{Soil}}) + (\%\text{Diet}_{\text{Prey}} \bullet C_{\text{Small Mammal}}))$$

Notes:

Biology-Related:

- IR = Ingestion rate (g/day)
- DR = Drinking rate (ml/day)
- $\%\text{Diet}_{\text{Soil}}$ = Soil diet proportion
- $\%\text{Diet}_{\text{Plant}}$ = Plant diet proportion
- $\%\text{Diet}_{\text{Invert}}$ = Invertebrate prey diet proportion
- $\%\text{Diet}_{\text{Prey}}$ = Prey diet proportion
- BW = Body weight (g)
- SPI = Site presence index (ha)

Chemical-Related:

- C_{water} = Chemical concentration in water
- C_{soil} = Chemical concentration in soil
- C_{plant} = Chemical concentration in plant
- C_{Invert} = Chemical concentration in invertebrate
- $C_{\text{Small Mammal}}$ = Chemical concentration in small mammal

Table 1
Exposure Formula and Parameters
Soil Ingestion Pathway
Georgia Pacific Corporation
Fort Bragg, California

Incidental Soil Ingestion

$$Intake \quad (mg/kg/day) = \frac{C_s \times CF \times IR \times EF \times ED}{BW \times AT}$$

Variable	Parameter	Value	Source/Rationale
C_s	Chemical Concentration in Soil	mg/kg	Units for soil
CF	Conversion factor, chemical fraction of soil	10^{-6} kg/mg	-
IR	Soil Ingestion Rate		
	Industrial/Commercial worker	50 mg/day	Adult soil ingestion rate (USEPA 1997a, 2002b)
	Construction Worker	330 mg/day	USEPA 2002b
	Visitor	- mg/day	to be determined
	On-site Resident		
	Adult	100 mg/day	USEPA 1991a, 2002b
	Child (age 0 to 6 years)	200 mg/day	USEPA 1991a, 2002b
EF	Exposure Frequency		
	Industrial/Commercial worker	250 days/year	Working 5-days per week (DTSC 1992; USEPA 1989, 1991a)
	Construction Worker	250 days/year	DTSC 2000a
	Visitor	- days/year	to be determined
	On-site Resident		
	Adult	350 days/year	USEPA 1991a, 2002b
	Child (age 0 to 6 years)	350 days/year	USEPA 1991a, 2002b
ED	Exposure Duration		
	Industrial/Commercial worker	25 years	Upper-bound occupational tenure
	Construction Worker	1 year	DTSC 2000a
	Visitor	- years	to be determined
	On-site Resident		
	Adult	24 years	USEPA 1991a, 2002b
	Child (age 0 to 6 years)	6 years	USEPA 1991a, 2002b
BW	Body Weight		
	Industrial/Commercial worker	70 kg	Adult (DTSC 1992, 1999; USEPA 1989, 1991a, 2002b)
	Construction Worker	70 kg	Adult (DTSC 1992, 1999; USEPA 1989, 1991a, 2002b)
	Visitor	- kg	to be determined
	On-site Resident		
	Adult	70 kg	Adult (DTSC 1992, 1999; USEPA 1989, 1991a, 2002b)
	Child (age 0 to 6 years)	15 kg	USEPA 1991a, 2002b
AT	Averaging Time		
	Carcinogen	70 years x 365 days/year	Lifetime (USEPA 1989)
	Non-carcinogen	ED x 365 days/year	USEPA 1989

Definitions:
days/year - days per year
kg - kilograms
mg/day - milligrams per day
mg/kg - milligrams per kilogram

Table 2
Exposure Formula and Parameters
Dermal Contact Pathway
Georgia Pacific Corporation
Fort Bragg, California

Dermal Exposure to Soil

$$Intake\ \ (mg/kg/day) = \frac{C_s \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

Variable	Parameter	Value	Source/Rationale
C_s	Chemical Concentration in Soil	mg/kg	Units for soil
CF	Conversion factor for chemical fraction of soil	10^{-6} kg/mg	-
SA	Skin surface area		
	Industrial/Commercial worker	3,300 cm^2	Exposed head, hands, and forearms (USEPA 2004a)
	Construction Worker	5,700 cm^2	DTSC 2000a
	Visitor	- cm^2	to be determined
	On-site Resident		
	Adult	5,700 cm^2	DTSC 2000a
	Child (age 0 to 6 years)	2,900 cm^2	DTSC 2000a
AF	Soil Adherence Factor		
	Industrial/Commercial worker	0.2 mg/cm^2	50th percentile for utility workers (USEPA 2004a)
	Construction Worker	0.8 mg/cm^2	DTSC 2000a
	Visitor	- mg/cm^2	to be determined
	On-site Resident		
	Adult	0.07 mg/cm^2	DTSC 2000; USEPA 2002b, 2004a
	Child (age 0 to 6 years)	0.2 mg/cm^2	DTSC 2000; USEPA 2002b, 2004a
ABS	Absorption Fraction	chemical-specific	DTSC 1999; USEPA 2004a
EF	Exposure Frequency		
	Industrial/Commercial worker	250 days/year	Working 5-days per week (DTSC 1992; USEPA 1989, 1991a)
	Construction Worker	250 days/year	USEPA 1991a, 2004a
	Visitor	- days/year	to be determined
	On-site Resident		
	Adult	350 days/year	USEPA 1991a, 2002b
	Child (age 0 to 6 years)	350 days/year	USEPA 1991a, 2002b
ED	Exposure Duration		
	Industrial/Commercial worker	25 years	Upper-bound occupational tenure
	Construction Worker	1 year	DTSC 2000a
	Visitor	- years	to be determined
	On-site Resident		
	Adult	24 years	USEPA 1991a, 2002b
	Child (age 0 to 6 years)	6 years	USEPA 1991a, 2002b
BW	Body Weight		
	Industrial/Commercial worker	70 kg	Adult (DTSC 1992, 1999; USEPA 1989, 1991a, 2002b)
	Construction Worker	70 kg	Adult (DTSC 1992, 1999; USEPA 1989, 1991a, 2002b)
	Visitor	- kg	to be determined
	On-site Resident		
	Adult	70 kg	Adult (DTSC 1992, 1999; USEPA 1989, 1991a, 2002b)
	Child (age 0 to 6 years)	15 kg	USEPA 1991a, 2002b
AT	Averaging Time		
	Carcinogen	70 years x 365 days/year	Lifetime (USEPA 1989)
	Non-carcinogen	ED x 365 days/year	USEPA 1989

Definitions:
cm^2/day - square centimeters per day
days/year - days per year
kg - kilograms
mg/cm^2 - milligrams per square centimeters
mg/day - milligrams per day

Table 3
Exposure Formula and Parameters
Inhalation of Dust and Vapor
Georgia Pacific Corporation
Fort Bragg, California

Inhalation of Dust/Vapor

$$Intake\ \left(mg/kg/day\right)=\frac{C_a \times IN \times ET \times EF \times ED}{BW \times AT}$$

Variable	Parameter	Value	Source/Rationale
C_a	Chemical Concentration in Airborne Dust or Vapor	mg/m^3	Units for air
IN	Inhalation rate		
	Industrial/Commercial worker, Outdoors	2.5 m^3/hour	USEPA 1991a, 1997a, 2002b
	Industrial/Commercial worker, Indoors	1.5	USEPA 1997a
	Construction Worker	2.5 m^3/hour	Mean for heavy activity by outdoor workers (USEPA 1997a)
	Visitor	- m^3/hour	to be determined
	On-site Resident		
	Adult	20 m^3/day	USEPA 1997a
	Child (age 0 to 6 years)	10 m^3/day	USEPA 1991a, 2002b
ET	Exposure time		
	Industrial/Commercial worker	8 hours/day	Workday (USEPA 1991a)
	Construction worker	8 hours/day	USEPA 1991a
	Visitor	- hours/day	to be determined
	On-site resident		
	Adult	24 hours/day	USEPA 1991a, 2004a
	Child (age 0 to 6 years)	24 hours/day	USEPA 1991a, 2004a
EF	Exposure Frequency		
	Industrial/Commercial worker	250 days/year	Working 5-days per week
	Construction worker	250 days/year	USEPA 1991a, 2004a
	Visitor	- days/year	to be determined
	On-site resident		
	Adult	350 days/year	USEPA 1991a
	Child (age 0 to 6 years)	350 days/year	USEPA 1991a
ED	Exposure Duration		
	Industrial/Commercial worker	25 years	Upper-bound occupational tenure
	Construction worker	1 year	DTSC 2000a
	Visitor	- years	to be determined
	On-site resident		
	Adult	24 years	USEPA 1991a, 2002b
	Child (age 0 to 6 years)	6 years	USEPA 1991a, 2002b
BW	Body Weight		
	Industrial/Commercial worker	70 kg	Adult (DTSC 1992, 1999; USEPA 1989, 1991a, 2002b)
	Construction Worker	70 kg	Adult (DTSC 1992, 1999; USEPA 1989, 1991a, 2002b)
	Visitor	- kg	to be determined
	On-site Resident		
	Adult	70 kg	Adult (DTSC 1992, 1999; USEPA 1989, 1991a, 2002b)
	Child (age 0 to 6 years)	15 kg	USEPA 1991a, 2002b
AT	Averaging Time		
	Carcinogen	70 years x 365 days/year	Lifetime (USEPA 1989)
	Non-carcinogen	ED x 365 days/year	USEPA 1989

Definitions:
days/year - days per year
hours/day - hours per day
kg - kilograms
m^3/hour - cubic meters per hour
mg/kg - milligrams per kilogram
mg/m^3 - milligrams per cubic meter

Table 4
Exposure Formula and Parameters
Potable Water Use -Groundwater Ingestion Pathway
Georgia Pacific Corporation
Fort Bragg, California

Ingestion of Groundwater

$$Intake\ (mg/kg/day) = \frac{C_w \times IR \times CF \times EF \times ED}{BW \times AT}$$

Variable	Parameter	Value	Source/Rationale
C_w	Chemical concentration in groundwater	µg/L	Units for water
IR	Water Ingestion Rate		
	On-site Resident		
	Adult	2 L/day	DTSC 1999
	Child (age 0 to 6 years)	1 L/day	DTSC 1999
CF	Unit conversion factor	10^{-3} mg/µg	-
EF	Exposure Frequency		
	On-site Resident		
	Adult	350 days/year	USEPA 1991a, 2002b
	Child (age 0 to 6 years)	350 days/year	USEPA 1991a, 2002b
ED	Exposure Duration		
	On-site Resident		
	Adult	24 years	USEPA 1991a, 2002b
	Child (age 0 to 6 years)	6 years	USEPA 1991a, 2002b
BW	Body Weight		
	On-site Resident		
	Adult	70 kg	Adult (DTSC 1992, 1999;
	Child (age 0 to 6 years)	15 kg	USEPA 1991a, 2002b
AT	Averaging Time		
	Carcinogen	70 years x 365 days/year	Lifetime (USEPA 1989)
	Non-carcinogen	ED x 365 days/year	USEPA 1989

Definitions:

days/year - days per year
kg - kilogram
L - liter
L/day - liters per day
µg/L - micrograms per liter
mg/µg - milligrams per microgram

Table 5
Exposure Formula and Parameters
Potable Water Use - Dermal Contact and Vapor Inhalation Pathways
Georgia Pacific Corporation
Fort Bragg, California

Dermal Contact With Groundwater and Inhalation of Vapors During Showering/Bathing

Dermal Contact

$$Intake\left(mg/kg/day\right)=\frac{C_w \times SA \times PC \times CF \times ET \times EF \times ED}{BW \times AT}$$

Inhalation

$$Intake\left(mg/kg/day\right)=\frac{C_a \times IN \times ET \times EF \times ED}{BW \times AT}$$

Variable	Parameter	Value	Source/Rationale
C_w	Chemical concentration in groundwater	µg/L	Units for water
Ca	Chemical concentration in shower air	mg/m^3	Units for air
SA	Skin surface area		
	On-site Resident		
	Adult	18,000 cm^2	USEPA 2004a
	Child (age 0 to 6 years)	6,600 cm^2	USEPA 2004a
IN	Inhalation rate		
	On-site Resident		
	Adult	0.8 m^3/hour	USEPA 1997a
	Child (age 0 to 6 years)	0.4 m^3/hour	USEPA 1991a, 2002b
PC	Dermal permeability constant	cm/hr	Chemical-specific
CF	Unit conversion factor	10^{-3} L/cm^3 x 10^{-3} mg/µg	-
ET	Exposure time		
	On-site Resident		
	Adult	0.25 hours/day	Based on a 15-minute shower (DTSC 1992)
	Child (age 0 to 6 years)	0.25 hours/day	Based on a 15-minute shower (DTSC 1992)
EF	Exposure Frequency		
	On-site Resident		
	Adult	350 days/year	USEPA 1991a, 2004a
	Child (age 0 to 6 years)	350 days/year	USEPA 1991a, 2004a
ED	Exposure Duration		
	On-site Resident		
	Adult	24 years	USEPA 1991a, 2002b
	Child (age 0 to 6 years)	6 years	USEPA 1991a, 2002b
BW	Body Weight		
	On-site Resident		
	Adult	70 kg	Adult (DTSC 1992, 1999;
	Child (age 0 to 6 years)	15 kg	USEPA 1991a, 2002b
AT	Averaging Time		
	Carcinogen	70 years x 365 days/year	Lifetime (USEPA 1989)
	Non-carcinogen	ED x 365 days/year	USEPA 1989

Definitions:

cm^2	-	square centimeters
cm^3	-	cubic centimeters
kg	-	kilogram
L	-	liter
L/cm^3	-	liters per cubic meter
µg/L	-	micrograms per liter
µg	-	micrograms
mg/µg	-	milligrams per microgram

Table 6
Exposure Formula and Parameters
Homegrown Produce Consumption Pathway
Georgia Pacific Corporation
Fort Bragg, California

Concentration in above ground produce due to root uptake

$$\Pr_{ag} = C_s \text{ x } Br_{ag}$$

Concentration in below ground produce due to root uptake

$$\Pr_{bg} = C_s \text{ x } Br_{rootveg} \text{ x } VG_{rootveg}$$

where

$$Br_{rootveg} = RCF \div Kd_s$$

Produce Consumption

$$Intake\ (mg/kg/day) = \frac{F_{ag} \times \left[(\Pr_{ag} \times CR_{ag}) + (\Pr_{ag} \times CR_{pp}) + (\Pr_{bg} \times CR_{bg})\right] \times EF \times ED}{AT}$$

Variable	Parameter	Value		Source/Rationale
Pr_{ag}	Concentration, above ground produce	calculated	mg/kg-plant DW	Concentration due to root uptake; USEPA 2005c
C_s	Chemical concentration, soil	measured	mg/kg-soil	Measured concentration
Br_{ag}	Plant-soil bioconcentration factor, above ground produce	chemical-specific	unitless	USEPA 2005c
Pr_{bg}	Concentration, below ground produce	calculated	mg/kg-plant DW	Concentration due to root uptake; USEPA 2005c
$Br_{rootveg}$	Plant-soil bioconcentration factor, belowground produce	chemical-specific	unitless	USEPA 2005c
$VG_{rootveg}$	Empirical correction factor for belowground produce			
	Lipophilic chemical	0.01	unitless	chemicals with log Kow > 4 (USEPA 2005c)
	Non-lipophilic chemical	1	unitless	chemicals with log Kow < 4 (USEPA 2005c)
RCF	Root concentration factor	chemical-specific	(mg/kg)/(mg/L)	USEPA 2005c
Kd_s	Soil/water partition coefficient	chemical-specific	L/kg	USEPA 2005c
F_{ag}	Fraction of produce from Site	1.0	unitless	Default, all produce consumed is from Site (USEPA 2005c)
CR_{ag}	Consumption rate, exposed aboveground produce			
	Resident			
	Adult	0.00032	kg-plant DW/kg-day	consumption per kg-body weight per day (USEPA 2005c)
	Child (0-6 years)	0.00077	kg-plant DW/kg-day	consumption per kg-body weight per day (USEPA 2005c)
CR_{pp}	Consumption rate, protected above ground produce			
	Resident			
	Adult	0.00061	kg-plant DW/kg-day	consumption per kg-body weight per day (USEPA 2005c)
	Child (0-6 years)	0.0015	kg-plant DW/kg-day	consumption per kg-body weight per day (USEPA 2005c)
CR_{bg}	Consumption rate, belowground produce.			
	Resident			
	Adult	0.00014	kg-plant DW/kg-day	consumption per kg-body weight per day (USEPA 2005c)
	Child (0-6 years)	0.00023	kg-plant DW/kg-day	consumption per kg-body weight per day (USEPA 2005c)
EF	Exposure Frequency			
	Resident			
	Adult	350	days/year	USEPA 1996,1997a, 2002b
	Child (0-6 years)	350	days/year	USEPA 1996, 1997a, 2002b
ED	Exposure Duration			
	Resident			
	Adult	24	years	USEPA 1996, 2002b, 2004a
	Child (0-6 years)	6	years	USEPA 1996, 2002b, 2004a
AT	Averaging Time			
	Carcinogen	70 years x 365 days/year		Lifetime (USEPA 1989a)
	Non-carcinogen	ED x 365 days/year		USEPA 1989a

Definitions:

DW	-	dry weight
kg	-	kilogram
kg-plant DW	-	kilogram of dry weight plant
log K_{ow}	-	logarithm of chemical octanol-water partition coefficient
L	-	liter
mg	-	milligram

Table 7
Special Status Plant and Animal Species with Moderate to High Potential for Occurrence
Georgia Pacific Corporation
Fort Bragg, California

Common Name	Scientific Name	Status[1]	Potential for Occurrence
Mammals			
Yuma myotis	*Myotis yumanensis*	FSC	Moderate
Birds			
California brown pelican	*Pelecanus occidentalis californicus*	FE, SE, CFP	High
Double-crested cormorant	*Phalacrocorax auritus*	CSC	High
Great blue heron	*Ardea herodias*	rookery protected	Present
Snowy egret	*Egretta thula*	FSC	Moderate
Osprey	*Pandion haliaetus*	CSC	Present
Western snowy plover	*Charadrius alexandrinus nivosus*	FT, CSC	Moderate
Allen's hummingbird	*Selasphorus sasin*	FSC	Moderate
Purple martin	*Progne subis*	CSC	Moderate
Loggerhead shrike	*Lanius ludovicianus*	FSC, CSC	Moderate
Yellow warbler	*Dendroica petechia*	CSC	Moderate
Lark sparrow	*Chondestes grammacus*	FSC	Moderate
Grasshopper sparrow	*Ammodramus savannarum*	FSC	Moderate
Plants			
Blasdale's bent grass	*Agrostis blasdalei*	List 1B	Present
Thurber's reed grass	*Calamagrostis crassiglumis*	List 2	Moderate
Swamp harebell	*Campanula californica*	List 1B	Moderate
Lakeshore sedge	*Carex lenticularis var. limnophila*	List 2	Moderate
Lyngbye's sedge	*Carex lyngbyei*	List 2	Moderate
Deceiving sedge	*Carex saliniformis*	List 1B	Moderate.
Green sedge	*Carex viridula var. viridula*	List 2	Moderate
Oregon coast Indian paintbrush	*Castilleja affinis ssp. litoralis*	List 2	Moderate
Mendocino Coast Indian Paintbrush	*Castilleja mendocinensis*	List 1B	Present
Supple daisy	*Erigeron supplex*	List 1B	Moderate
Roderick's fritillary	*Fritillaria roderickii*	List 1B, SE	Moderate
Hayfield tarplant	*Hemizonia congesta ssp. luecocephala*	List 3	Moderate
Short leaved evax	*Hesperevax sparsiflora var. brevifolia*	List 2	Present
Point Reyes horkelia	*Horkelia marinensis*	List 1B	Moderate
Hair-leaved rush	*Juncus supiniformis*	List 2	Moderate
Baker's goldfields	*Lasthenia macrantha ssp. bakeri*	List 1B	Moderate
Coast lily	*Lilium maritimum*	List 1B	Moderate
Leafy stemmed mitrewort	*Mitella caulescens*	List 2	Moderate
North coast sephamore grass	*Pleuropogon hooverianus*	List 1B, ST	Moderate
Maple leaved checkerbloom	*Sidalcea malachroides*	List 1B	Moderate
Coastal triquetrella	*Triquetrella californica*	List 1B	Moderate

[1] Key to status codes:

FE - Federal Endangered
FT - Federal Threatened
FC - Federal Candidate
FSC - United States Fish and Wildlife Service Federal Species of Concern
CSC - CDFG Species of Special Concern, CSC (Draft) - 4 April 2001 Draft

List 1B - CNPS 1B List, Endangered, Threatened, or Rare in California
List 2- CNPS List 2 Plants are rare, threatened, or endangered in California, but more common elsewhere

Table 8
Selected Indicator Species and Habitat Usage
Georgia Pacific Corporation
Fort Bragg, California

Guild	Common Name	Scientific Name	Habitat Usage FEW	AGS	MAR
PLANTS					
	Grasses and forbs		Yearlong	Yearlong	
	Shrubs			Yearlong	
	Trees				
INVERTEBRATES					
	Earthworm			Yearlong	
	Sediment invertebrate		Yearlong		
	Aquatic invertebrate		Yearlong		
HERBIVORES					
	Western Pond Turtle	*Clemmys marmorata*	Yearlong	Summer	
	White-crowned Sparrow	*Zonotrichia leucophrys*		Winter	
	California Vole	*Microtus californicus*	Yearlong	Yearlong	
	Mule Deer	*Odocoileus hemionus*	Yearlong	Yearlong	
INSECTIVORES					
	Pacific Chorus Frog	*Pseudacris regilla*	Yearlong	Yearlong	
	Western Fence Lizard	*Sceloporus occidentalis*		Yearlong	
	Marsh Wren	*Cistothotrus palustris*	Yearlong		
	Killdeer	*Charadrius vociferus*	Yearlong	Yearlong	Yearlong
	Ornate Shrew	*Sorex ornatus*	Yearlong	Yearlong	
OMNIVORES					
	Mallard	*Anas platyrhynchos*	Yearlong	Yearlong	
CARNIVORES					
	American Kestrel	*Falco sparverius*	Yearlong	Yearlong	
	Coyote	*Canis latrans*	Yearlong	Yearlong	

Definitions:

FEW - Fresh Emergent Wetland
AGS - Annual Grassland
MAR - Marine (coastal)

Table 9
Wildlife Exposure Factors for Representative Species
Georgia Pacific Corporation
Fort Bragg, California

Guild / Common Name	Scientific Name	Body Weight [FW] (g)	Food Ingestion Rate [DW] (g/d)	Drinking Rate (mL/day)	Diet[a]	Diet Proportions: Soil	Plant	Invert.	Mammal	Soil Depth[b] (ft bgs)	Home Range or Territory (ha)	Source
Plants												
Grasses and forbs		—	—	—	—	—	—	—	—	0-1	Less than AOC	
Shrubs		—	—	—	—	—	—	—	—	0-2	Less than AOC	
Trees		—	—	—	—	—	—	—	—	Ground water	Less than AOC	
Invertebrates												
Aquatic invert. community		—	—	—	—	—	—	—	—	Surface water	Less than AOC	
Sediment invert. community		—	—	—	—	—	—	—	—	Sediment	Less than AOC	
Earthworm		—	—	—	—	—	—	—	—	0-1	Less than AOC	
Amphibians												
Pacific Chorus Frog	*Pseudacris regilla*	-	—	—	Invertebrates	6%	0%	100%	0%	Surface water	Less than AOC	
Birds												
Herbivorous birds												
White-crowned sparrow	*Zonotrichia leucophrys*	25	7.56	5.0	Seeds	10.4%	100%	0%	0%	0-1	4.2	1,5,6,9
Insectivorous birds												
Marsh wren	*Cistothorus palustris*	10.6	3.87	2.8	Soil invertebrates	10.4%	0%	100%	0%	0-1	0.12	1,5,6,11
Killdeer	*Charadris vociferus*	101	18.15	12.7	Soil invertebrates	18.0%	0%	100%	0%	Sediment	6	1,5,6,12
Carnivorous birds												
American kestrel	*Falco sparverius*	121	20.41	0	Small mammals	5.0%	0%	0%	100%	0-1	21	2,5,7,8
Waterfowl and Wading Birds												
Mallard	*Anas platyrhynchos*	1,082	76.4	62.2	Emergent aquatic plants, aquatic invertebrates	3.3%	88.0%	12.0%	0%	Sediment	111	2,5,6,8
Mammals												
Herbivorous mammals												
California vole	*Microtus californicus*	54	10.52	7.2	Grasses and forbs	2.4%	100%	0%	0%	0-1	0.55	3,5,6,9
Mule Deer	*Odocoileus hemionus*	39,100	256	2683	Grasses and forbs	2.0%	100%	0%	0%	0-2	100	4,5,6,11
Insectivorous mammals												
Ornate shrew	*Sorex ornatus*	5.0	1.02	0.841	Soil invertebrates	3.7%	0%	100%	0%	0-5	0.11	3,5,6,10
Omnivorous mammals												
Deer Mouse	*Peromyscus maniculatus*	17.9	3.81	2.6	Soil invertebrates	2.0%	50%	50%	0%	0-5	0.1	4,5,6,11
Carnivorous mammals												
Coyote	*Canis latrans*	14,000	439.10	1065	Small mammals	2.8%	0%	0%	100%	0-1	3,150	3,5,6,8

Table 9
Wildlife Exposure Factors for Representative Species
Georgia Pacific Corporation
Fort Bragg, California

Definitions:

AOC	-	Area of concern.
bgs	-	below ground surface.
ERA	-	Environmental risk assessment.
FW	-	Fresh weight.
DW	-	Dry weight.
ft	-	Feet.
g	-	Grams.
g/d	-	Grams per day.
ha	-	Hectares.
mL/d	-	Milliliters per day.
U. S. EPA	-	U.S. Environmental Protection Agency.

Note:

a	-	Food type evaluated for the baseline ERA.
b	-	Soil depth interval within which a given representative species was assumed to uptake or ingest soil.

Sources:

1	-	Average body weights of birds were taken from Dunning 1984. Female values were used to relate to reproductive endpoints.
2	-	Body weights were taken from average of female mean body weights in U.S. EPA (1993a).
3	-	Body weight ranges of mammals were taken from Jameson and Peeters 1988.
4	-	Body weight and ingestion rates of mammals were taken from Nagy 2001.
5	-	Food ingestion and water intake rates were calculated using allometric regression equations (Nagy 2001; U.S. EPA 1993a).
6	-	Percent soil in diet were obtained from Beyer *et al.* (1994). Values were derived from species with similar feeding biology.
7	-	Percent soil in diet were obtained from Thomsen (1971). In the case of the American kestrel, the value was derived from a species with similar feeding biology.
8	-	Territory or home range from U.S. EPA (1993a)
9	-	Territory or home range from Bekoff (1977).
10	-	Territory or home range from range for short-tailed shrew (Platt 1976 in U.S. EPA 1993a)
11	-	Territory or home range from range from CA Habitat Relationships
12	-	Territory or home range from range for killdeer in N. California (Plissner et al. 2000 as reported in the Birds of Nort

APPENDIX A

SUMMARY OF SAMPLING WORKPLANS

APPENDIX A-1

SUMMARY OF SAMPLING WORKPLAN 1

APPENDIX A-1
TABLE 1
(Source: AME 2005a)
AREA-SPECIFIC INFORMATION
Georgia-Pacific Corporation California Wood Products Manufacturing Facility
90 West Redwood Avenue, Fort Bragg, California

Areas Addressed in Work Plan	Process	Substance Used or Waste Products	COPCs	Test Method	RL/MDL (mg/kg)
Compressor House (Bldg. #11)	Compressors	Compressor Oil	TPHo	EPA 8015	1
Former Sawmill #1 (Bldg. #12)	Machinery routine maintenance at sawmills, planing mills, sorting mills, debarkers, chippers, etc. Lumber surface treatment.	Hydraulic oils and machine lubricants; petroleum solvents	TPH as stoddard, naphtha solvents (petroleum-based solvents in range of TPHd); TPH as lubricants (in range of TPHo)	EPA 8015	1
		Chlorinated solvents, paint solvents	VOCs	EPA 8260	0.005 for most
		Pentachlorophenol, technical grade	Pentachlorophenol	EPA 8270	0.67
			Tetrachlorophenol	EPA 8270	
Lath Plant	Machinery routine ma	Hydraulic oils and machine lubricants; petroleum solvents	TPH as stoddard, naphtha solvents (petroleum-based solvents in range of TPHd); TPH as lubricants (in range of TPHo)	EPA 8015	1
		Chlorinated solvents, paint solvents	VOCs	EPA 8260	0.005 for most
		Pentachlorophenol, technical grade	Pentachlorophenol	EPA 8270	0.67
			Tetrachlorophenol	EPA 8270	

APPENDIX A-1
TABLE 1
(Source: AME 2005a)
AREA-SPECIFIC INFORMATION
Georgia-Pacific Corporation California Wood Products Manufacturing Facility
90 West Redwood Avenue, Fort Bragg, California

Areas Addressed in Work Plan	Process	Substance Used or Waste Products	COPCs	Test Method	RL/MDL (mg/kg)
Powerhouse (Bldg. #13)	Boiler Fueling and Operation	Bunker C, residual fuel	TPHo	EPA 8015	1
			PAHs	EPA 8270	0.067/ 0.01
			CA Title 22 Metals	EPA 6010B/ 7400	0.15 to 1
		Motor oil, used	TPHo	EPA 8015	1
			VOCs	EPA 8260	0.005 for most
			PAHs	EPA 8270	0.067/ 0.01
			CA Title 22 Metals	EPA 6010B/ 7400	0.15 to 1
		Bottom ash waste, may include clinker	PAHs	EPA 8270	0.067/ 0.01
			Dioxins and furans	EPA 8290	1.00E-06
			CA Title 22 Metals	EPA 6010B/ 7400	0.15 to 1
	Power generation	Turbine oil, hydraulic oil, machine lubricants, petroleum solvents	TPHd, TPHo	EPA 8015	1
			VOCs	EPA 8260	0.005 for most
Paint Storage Shed	Paint and solvent stora	Paint, paint thinners, so	TPH as kerosene, stoddard, naphtha solvents (petroleum-based solvents in range of TPHd)	EPA 8015	1
			VOCs	EPA 8260	0.005 for most
			CA Title 22 Metals	EPA 6010B/ 7400	0.15 to 1
Transformer Pad	Power distribution	Transformer cooling oil	PCBs, individual cogeners	EPA 8082	0.012
			TPH as lubrincants (in range of TPHo)	EPA 8015	1
Oil Storage Shed	Oil storage	Lubricating oil, used oil	TPHo	EPA 8015	1
			VOCs	EPA 8260	0.005 for most
			PAHs	EPA 8270	0.067/ 0.01
			CA Title 22 Metals	EPA 6010B/ 7400	0.15 to 1

APPENDIX A-1
TABLE 1
(Source: AME 2005a)
AREA-SPECIFIC INFORMATION
Georgia-Pacific Corporation California Wood Products Manufacturing Facility
90 West Redwood Avenue, Fort Bragg, California

Areas Addressed in Work Plan	Process	Substance Used or Waste Products	COPCs	Test Method	RL/MDL (mg/kg)
Press Building	Machinery routine maintenance	Hydraulic oils and machine lubricants; petroleum solvents	TPH as stoddard, naphtha solvents (petroleum-based solvents in range of TPHd); TPH as lubricants (in range of TPHo)	EPA 8015	1
		Chlorinated solvents, paint solvents	VOCs	EPA 8260	0.005 for most
	Compressors	Compressor Oil	TPHo	EPA 8015	1
Cooling Towers	Boiler coolant/ cooling towers	Corrosion inhibitors, water conditioners	Cr VI+	EPA 3060A w/ 7199	0.5
			Sodium molybdate	EPA 6010B	1
		Disinfectants/ other	Ethanol	EPA 8260	100
			Isopropanol	EPA 8260	100
Cooling Towers Shed, Poly Tanks Pad	Boiler coolant/ cooling towers	Corrosion inhibitors, water conditioners	Cr VI+	EPA 3060A w/ 7199	0.5
			Sodium molybdate	EPA 6010B	1
		Disinfectants/ other	Ethanol	EPA 8260	100
			Isopropanol	EPA 8260	100
Truck Dump	Routine maintenance of hydraulic unit	Hydraulic oils and machine lubricants; petroleum solvents	TPH as stoddard, naphtha solvents (petroleum-based solvents in range of TPHd); TPH as lubricants (in range of TPHo)	EPA 8015	1
		Chlorinated solvents, paint solvents	VOCs	EPA 8260	0.005 for most

APPENDIX A-1
TABLE 1
(Source: AME 2005a)
AREA-SPECIFIC INFORMATION
Georgia-Pacific Corporation California Wood Products Manufacturing Facility
90 West Redwood Avenue, Fort Bragg, California

Areas Addressed in Work Plan	Process	Substance Used or Waste Products	COPCs	Test Method	RL/MDL (mg/kg)
Fly Ash Reinjection System	Fly ash processing	Ash waste	PAHs	EPA 8270	0.067/ 0.01
			Dioxins and furans	EPA 8290	1.00E-06
			CA Title 22 Metals	EPA 6010B/ 7400	0.15 to 1
Fuel Barn (Bldg. #14)	Machinery routine maintenance at sawmills, planing mills, sorting mills, debarkers, chippers, etc.	Hydraulic oils and machine lubricants; petroleum solvents	TPH as stoddard, naphtha solvents (petroleum-based solvents in range of TPHd); TPH as lubricants (in range of TPHo)	EPA 8015	1
		Chlorinated solvents, paint solvents	VOCs	EPA 8260	0.005 for most
Chipper Bldg. (Bldg. #15)	Machinery routine maintenance at sawmills, planing mills, sorting mills, debarkers, chippers, etc.	Hydraulic oils and machine lubricants; petroleum solvents	TPH as stoddard, naphtha solvents (petroleum-based solvents in range of TPHd); TPH as lubricants (in range of TPHo)	EPA 8015	1
		Chlorinated solvents, paint solvents	VOCs	EPA 8260	0.005 for most
Powerhouse Fuel Storage (Bldg. #17)	Fuel storage	Bunker C, residual fuel	TPHo	EPA 8015	1
			PAHs	EPA 8270	0.067/ 0.01
			CA Title 22 Metals	EPA 6010B / 7400	0.15 to 1
		Jet fuel	TPHd	EPA 8015	1
			VOCs	EPA 8260	0.005 for most
			PAHs	EPA 8270	0.067/ 0.01
			Lead	EPA 6010B	0.15

APPENDIX A-1
TABLE 1
(Source: AME 2005a)
AREA-SPECIFIC INFORMATION
Georgia-Pacific Corporation California Wood Products Manufacturing Facility
90 West Redwood Avenue, Fort Bragg, California

Areas Addressed in Work Plan	Process	Substance Used or Waste Products	COPCs	Test Method	RL/MDL (mg/kg)
Water Supply Switch Building	Machinery routine maintenance at sawmills, planing mills, sorting mills, debarkers, chippers, etc.	Hydraulic oils and machine lubricants; petroleum solvents	TPH as stoddard, naphtha solvents (petroleum-based solvents in range of TPHd); TPH as lubricants (in range of TPHo)	EPA 8015	1
		Chlorinated solvents, paint solvents	VOCs	EPA 8260	0.005 for most
Dewatering Slabs	Fly ash processing	Ash waste	PAHs	EPA 8270	0.067/ 0.01
			Dioxins and furans	EPA 8290	1.00E-06
			CA Title 22 Metals	EPA 6010B/ 7400	0.15 to 1
Sewage Pumping Station	Machinery routine maintenance at sawmills, planing mills, sorting mills, debarkers, chippers, etc.	Hydraulic oils and machine lubricants; petroleum solvents	TPH as stoddard, naphtha solvents (petroleum-based solvents in range of TPHd); TPH as lubricants (in range of TPHo)	EPA 8015	1
		Chlorinated solvents, paint solvents	VOCs	EPA 8260	0.005 for most
Former Mobile Equipment Shop (Parcel 3)	Vehicle Maintenance	Gasoline, diesel, used motor oil, hydraulic oil, degreasers	TPHg	EPA 8015	1
			TPHd, TPHo	EPA 8015	1
			VOCs	EPA 8260	0.005 for most
			PAHs	EPA 8270	0.067 / 0.01
			CA Title 22 Metals	EPA 6010B/7400	0.015 to 1

APPENDIX A-1
TABLE 1
(Source: AME 2005a)
AREA-SPECIFIC INFORMATION
Georgia-Pacific Corporation California Wood Products Manufacturing Facility
90 West Redwood Avenue, Fort Bragg, California

Areas Addressed in Work Plan	Process	Substance Used or Waste Products	COPCs	Test Method	RL/MDL (mg/kg)
Glass Beach Nos. 1 - 3	Waste Fill	May possibly include log deck scrapings, bottom ash waste, clinker, fly ash, burn debris, waste diesel, motor oil, solvents.	TPHd, TPHo	EPA 8015	1
			VOCs	EPA 8260	0.005 for most
			PAHs	EPA 8270	0.067/ 0.01
			Dioxins and furans	EPA 8290	1.00E-06
			PCBs, individual cogeners	EPA 8082	0.012
			CA Title 22 Metals	EPA 6010B/ 7400	0.15 to 1
Geophysical Anomaly Areas, Parcels 3 and 10	Waste Fill	May possibly include log deck scrapings, bottom ash waste, clinker, fly ash, burn debris, waste diesel, motor oil, solvents.	TPHd, TPHo	EPA 8015	1
			VOCs	EPA 8260	0.005 for most
			PAHs	EPA 8270	0.067/ 0.01
			Dioxins and furans	EPA 8290	1.00E-06
			PCBs, individual cogeners	EPA 8082	0.012
			CA Title 22 Metals	EPA 6010B/ 7400	0.15 to 1

Notes
PAHs by EPA 8270 to be reported to the method detection limit (MDL).
PCBs by EPA 8082 analyze for individual cogeners.
For dioxins and furans by 8290 in general, and PCBs by 8082 at waste fill locations, analyze select soil samples where ash/ waste oil, or maximum PAH concentrations are present.

CA = California
COPC = chemical(s) of potential concern
EPA = United States Environmental Protection Agency
CHHSL = California Human Health Screening Level
PAH = Polycyclic Aromatic Hydrocarbon
PCB = polychlorinated biphenyl

RL/MDL = Reporting Limit / Method Detection Limit
TPH = Total Petroleum Hydrocarbon(s)
TPHd = Total Petroleum Hydrocarbon(s) as diesel
TPHg = Total Petroleum Hydrocarbon(s) as gasoline
TPHo = Total Petroleum Hydrocarbon(s) as motor oil
VOC = Volatile Organic Compound

APPENDIX A-2

SUMMARY OF SAMPLING WORKPLAN 2

APPENDIX A-2 TABLE 5 (AME 2005b)

PROPOSED SAMPLING AND ANALYSIS SUMMARY
Georgia-Pacific California Wood Products Manufacturing Facility
90 West Redwood Avenue, Fort Bragg, California

Sampling	Analysis	Further Action
5.1 Parcel 1		
5.1.1 Pump House		
• Two direct push soil borings will be advanced west of the Pump House, with continuous soil and grab ground water sampling performed at each soil boring.	Select soil and ground water samples will be analyzed for TPHd, TPHo, and VOCs.	Based on the analytical results, one or more ground water monitoring wells will be installed with 10 feet of screen casing as described in the SAP (Appendix A) to evaluate ground water conditions in the area.
5.1.2 Explosives Bunker		
• The interior of the bunker will be inspected with a remote/fiber optic camera to verify that it is empty. • Two direct push soil borings will be advanced to the water table. One boring will be located immediately outside the door on the north side of the bunker, and one boring will be located 50 feet to the north in the area of the former wooden shed (Figure 5).	Soil and grab ground water samples will be analyzed for nitrate and nitroglycerine.	
5.2 Parcel 2		
5.2.1 High-Ceiling Wooden Warehouse		
• Two ground water monitoring wells will be constructed and screened from 5 to 15 feet bgs. – One ground water monitoring well will be installed west of the Breezeway between the Resaw #5 and Glue Lam Areas, downgradient of monitoring well MW-2.3.	Soil samples will be selectively analyzed for formaldehyde using EPA Method 8315, and ground water samples will be selectively analyzed for TPHo using EPA Method 8015, TPHd, TPHg, VOCs, phenol, resorcinol, and	

APPENDIX A-2 TABLE 5 (AME 2005b)

PROPOSED SAMPLING AND ANALYSIS SUMMARY
Georgia-Pacific California Wood Products Manufacturing Facility
90 West Redwood Avenue, Fort Bragg, California

Sampling	Analysis	Further Action
? Based on a northwesterly historical ground water-flow direction in this area, the monitoring well will be located approximately 50 feet west of the Breezeway to evaluate the downgradient extent of ground water TPHd impact reported at soil borings P2-2, P2-4A, P2-5, and P2-6, and monitoring well MW-2.3. – One monitoring well will be installed southeast of soil boring P2-2 to evaluate ground water conditions upgradient of the facility.	CA Title 22 metals.	
5.2.2 Helicopter Landing Pad		
• Two ground water monitoring wells will be constructed and screened from 5 to 15 feet bgs. – One monitoring well will be installed northwest of monitoring well MW-2.1 to evaluate downgradient ground water conditions. – One monitoring well will be installed northwest of soil boring P2-11 to further evaluate TPHd impact reported in the grab ground water sample from that soil boring.	Soil and ground water samples will be collected and selectively analyzed for TPHd, TPHg, VOCs (including benzene, toluene, ethylbenzene, and xylenes), and CA Title 22 metals.	
5.3 Parcel 3		
5.3.1 Railroad Spurs		
• A total of 12 soil borings. – Two of the soil borings along the Railroad Spur will be located near previous soil boring P3-12 and continuously sampled to the water table, where grab ground water samples will be collected to evaluate the lateral and vertical extent of COPC impact where the soil TPHd concentration is the highest.	Soil and ground water samples will be analyzed for TPHo using EPA Method 8015, TPHd, VOCs, PAHs, and CA Title 22 metals.	

APPENDIX A-2 TABLE 5 (AME 2005b)

PROPOSED SAMPLING AND ANALYSIS SUMMARY
Georgia-Pacific California Wood Products Manufacturing Facility
90 West Redwood Avenue, Fort Bragg, California

Sampling	Analysis	Further Action
5.3.2 Former Planer #1		
• Four direct push soil borings with grab ground water sampling will be advanced and continuously soil sampled to the water table at locations intermediate to former soil borings 98-P1-1 through 98-P1-4.	Select soil samples will be analyzed for pentachlorophenol, tetrachlorophenol, dioxins and furans (where pentachlorophenol is detected), propiconazole, didecyldimethylammonium chloride (DDAC), TPHd, TPHo, and VOCs.	
• Three direct push soil borings will be advanced and continuously soil sampled to the water table in the former transformer area between Former Planer #1 and Planer #50.	Selected soil samples will be analyzed for TPHo using EPA Method 8015 and PCBs.	Based on the findings an evaluation will be made to select monitoring well locations (tentative locations are shown on Figure 7): One ground water monitoring well will be constructed where sample analysis indicates the greatest potential impact and screened from 5 to 15 feet bgs, and a second monitoring well will be installed downgradient of the first monitoring well as described below and

PROPOSED SAMPLING AND ANALYSIS SUMMARY
Georgia-Pacific California Wood Products Manufacturing Facility
90 West Redwood Avenue, Fort Bragg, California

Sampling	Analysis	Further Action
		based on the historical ground water flow direction. One ground water monitoring well will be constructed and screened from 5 to 15 feet bgs to characterize TPHd and TPHo impact downgradient of Former Planer #1.
• Two direct push borings with soil and grab ground water sampling will be advanced at the two sand- and wood-filled foundation pits in the northeast area of Former Planer #1.	The grab ground water and selected soil samples will be analyzed for TPHd, TPHo, PAHs, and VOCs.	
5.3.3 Dry Shed Numbers 4 and 5		
• Two soil borings will be advanced and continuously soil sampled down to the water table, where grab ground water samples will be collected, within the Former Lumber Treating Building Area. – Of the two soil borings, one will be located approximately 40 feet south of the northwest corner of Dry Shed #4 and the second approximately 60 feet north of the northwest corner. • One soil boring further downgradient will be advanced and continuously soil sampled down to the water table, where a grab ground water sample will be collected, approximately 75 feet west-southwest of the northwest corner of Dry Shed #4.	Soil and ground water samples will be selectively analyzed for pentachlorophenol, tetrachlorophenol, and dioxins and furans (where pentachlorophenol is detected).	

APPENDIX A-2 TABLE 5 (AME 2005b)

PROPOSED SAMPLING AND ANALYSIS SUMMARY
Georgia-Pacific California Wood Products Manufacturing Facility
90 West Redwood Avenue, Fort Bragg, California

Sampling	Analysis	Further Action
5.3.4 Former Mobile Equipment Shop		
• Four soil borings with grab ground water sampling will be advanced east, northeast, west, and southwest of the Former Mobile Equipment Shop. • Based on an evaluation of data from the initial borings, approximately three ground water monitoring wells will be constructed in the vicinity of the Former Mobile Equipment Shop (soil samples will be collected at 5-foot intervals during drilling, and grab ground water samples will be collected at the water table). • One soil boring with grab ground water sampling will be advanced at the 12,000-gallon UST located approximately 150 feet northeast of the Former Mobile Equipment Shop. • One soil boring will be advanced at the 25,000-gallon diesel AST located approximately 150 feet northeast of the Former Mobile Equipment Shop.	Soil and ground water samples from the Former Mobile Equipment Shop and vicinity will be selectively analyzed for TPHd, TPHg, TPHo, VOCs, CA Title 22 metals, ethylene glycol, and PAHs. Selected soil samples and a grab ground water sample from the boring near the gasoline UST will be analyzed for TPHg using EPA Method 8015, VOCs using EPA Method 8260, and lead using EPA Method 6010B/7400. Selected soil samples and a grab ground water sample from the boring near the diesel AST boring will be analyzed for TPHd using EPA Method 8015, BTEX using EPA Method 8260, and PAHs using EPA Method 8270.	

APPENDIX A-2 TABLE 5 (AME 2005b)

PROPOSED SAMPLING AND ANALYSIS SUMMARY
Georgia-Pacific California Wood Products Manufacturing Facility
90 West Redwood Avenue, Fort Bragg, California

Sampling	Analysis	Further Action
5.3.5 Construction Engineering		
• Two soil borings will be advanced with a direct push drill rig and continuously soil sampled to the water table, where grab ground water samples will be collected, in the area of the portable storage shed.	Soil and ground water samples will be selectively analyzed for TPHd, TPHo, VOCs, PCBs, CA Title 22 Metals, and PAHs.	A ground water monitoring well (with 10 feet of screen casing) may be installed, if warranted, based on the analytical results of grab ground water samples.
5.3.6 Machine Shop / Sheet Metal / Plumbing / Plant Supply		
• Twelve soil borings will be advanced at locations where sample analysis reported impact by petroleum hydrocarbons and continuously soil sampled down to the water table, where grab ground water samples will be collected (this drilling program will be undertaken following building demolition under a future CDP). – Three direct push soil borings will be advanced around previous soil boring P3-49 to evaluate the extent of COPC impact in soil in the area near the Storage Shed. – Three soil borings will be advanced near previous soil boring P3-51 (interior of the Machine Shop) to evaluate the extent of COPC impact in soil within the structure. – Four soil borings will be advanced near previous soil boring P3-50 and the oil-stained area at the southwest corner of the Machine Shop. – One soil boring will be advanced near the sump containing and oily material. – One soil boring will be advanced next to the possible track pit.	Soil and ground water samples will be selectively analyzed for TPHd, TPHo, VOCs, PCBs, PAHs, and CA Title 22 metals.	If warranted, additional soil boring locations will be evaluated based on the analytical results.

APPENDIX A-2 TABLE 5 (AME 2005b)

PROPOSED SAMPLING AND ANALYSIS SUMMARY
Georgia-Pacific California Wood Products Manufacturing Facility
90 West Redwood Avenue, Fort Bragg, California

Sampling	Analysis	Further Action
5.3.7 Covered Shed		
• Three direct push soil borings will be advanced and continuously sampled to the water table, where grab ground water samples will be collected, following demolition of the building under a future CDP. – One soil boring will be advanced east of the building. – One soil boring will be advanced within the building footprint. – One soil boring will be advanced west of the building.	Soil samples will be selected for laboratory testing based on visual field observations and PID screening. Soil and ground water samples will be analyzed for TPHd, TPHo, VOCs, PAHs, and CA Title 22 metals.	
5.4 Parcel 4		
5.4.1 Ponds		
• Three soil borings will be advanced in each of Ponds 6 and 7 and continuously sampled until native material is encountered. • Three soil borings will be advanced in the Former South Pond Area and one soil boring will be advanced in the Former North Pond Area and continuously sampled until native material is encountered. • Sediment samples will be collected at each pond using the following general procedure. – The sampling location will be land surveyed using GPS equipment. – The water depth will be measured at each sampling location using a weighted tape measure. – Sediment thickness at each location will be measured using a sediment probe manually pushed into the sediment. – An appropriate sediment sampling device will be selected based on the sediment thickness at each sampling location.	Sediment samples will be selectively analyzed for TPHg, TPHd, TPHo, VOCs, PAHs, cyanide, PCBs, dioxins and furans, hexavalent chromium (Cr VI), and CA Title 22 metals. Surface water samples will be field-filtered and analyzed for CA Title 22 metals.	Based on the results of the associated sediment sample analyses, an additional surface water sample may be collected at a later date for the analysis of COPCs reported in the sediment sample.

PROPOSED SAMPLING AND ANALYSIS SUMMARY
Georgia-Pacific California Wood Products Manufacturing Facility
90 West Redwood Avenue, Fort Bragg, California

Sampling	Analysis	Further Action
- Sediment samples will be retained from the top of the sediment and at no greater than 5-foot intervals thereafter in order to characterize the full sediment thickness. • Samples will be retained within clear acetate liners and examined both visually and with a photo ionization detector (PID) or flame ionization detector (FID) for COPC impact evidence. • A surface water sample will be collected near the sediment-water interface at each sediment sampling location to evaluate the interaction between the water and underlying sediment.		
5.4.2 Equipment Fueling Area near the Hog Fuel Pile		
• Two direct push borings will be advanced and continuously soil sampled down to the water table, where grab ground water samples will be collected.	Soil and ground water samples will be selectively analyzed for target-analyte compounds associated with diesel fuel (i.e., TPHd, BTEX, and PAHs).	
5.4.3 Former Bunker Fuel Aboveground Storage Tanks		
• Four direct push soil borings will be advanced and continuously sampled to the water table, where grab ground water samples will be collected, in the impacted area identified in the 1992 GTI investigation report.	Soil and ground water samples will be selectively analyzed for TPHo, TPHd, PAHs, and CA Title 22 metals.	After reviewing the analytical data, additional soil boring locations may be selected to further assess the extent of soil and ground water COPC impact.

APPENDIX A-2 TABLE 5 (AME 2005b)

PROPOSED SAMPLING AND ANALYSIS SUMMARY
Georgia-Pacific California Wood Products Manufacturing Facility
90 West Redwood Avenue, Fort Bragg, California

Sampling	Analysis	Further Action
5.5 Parcel 5		
5.5.1 Truck Wash Pit		
• RWQCB memos and photographs will be reviewed to assist sampling location placement. • Three direct push soil borings will be advanced and continuously sampled to the water table, where grab ground water samples will be collected, in the area (discussed in Section 5.5.5.3 also).	Soil and ground water samples will be analyzed for TPHg, TPHd, TPHo, VOCs, CA Title 22 metals, and PAHs based on visual observations and PID screening.	
5.5.2 Mobile Equipment Shop		
Soil sampling of areas beneath foundations will be conducted following foundation excavation and removal under a future CDP. Proposed investigation (see Figure 9) includes: • The fuel-transmission pipeline west of the building will be excavated and removed. Soil in the excavation will be assessed for petroleum impact. If warranted, soil samples will be collected from the excavation for laboratory analysis. • Four soil borings will be advanced and continuously sampled down to the water table, where grab ground water samples will be collected to aid in the placement of ground water monitoring wells, outside of the area encompassed by previous soil borings P5-22 through P5-24 to characterize the lateral and vertical extent of soil COPC impact. • At least one soil boring will be advanced and continuously sampled down to the water table, where a grab ground water sample will be collected to aid in the placement of ground water monitoring wells, at the north shed to evaluate potential sources of COPC impact. • At least one soil boring will be advanced and continuously sampled down to the water table, where a grab ground water sample will be collected to aid in the placement of ground water monitoring wells, at the west shed to evaluate potential sources of COPC impact.	Selected soil and ground water samples will be analyzed for TPHd, TPHg, TPHo, VOCs, CA Title 22 metals, and PAHs. Selected ground water samples will be analyzed for ethylene glycol. Soil samples collected during drilling of the two monitoring wells will be analyzed for TPHd using EPA Method 8015, BTEX using EPA Method 8260m and PAHs using EPA Method 8270.	

APPENDIX A-2 TABLE 5 (AME 2005b)

PROPOSED SAMPLING AND ANALYSIS SUMMARY
Georgia-Pacific California Wood Products Manufacturing Facility
90 West Redwood Avenue, Fort Bragg, California

Sampling	Analysis	Further Action
• Two monitoring wells will be installed approximately 75 feet northwest and southwest of pothole P5-PH3 where TPHd impacts to soil were reported in the TRC July 2004 investigation.		
An evaluation of ground water conditions in the vicinity of the Mobile Equipment Shop will tentatively be performed, including: • One monitoring well north of the building constructed and screened from 5 to 20 feet bgs. • One monitoring well south of the oil-change pit constructed and screened from 5 to 20 feet bgs to evaluate the extent of ground water COPC impact to the north and south. • One monitoring well downgradient (to the west-northwest and toward Pond 8) of locations P5-PH1, P5-PH4, P5-PH5, and P5-PH6 and screened from 5 to 20 feet bgs. • In an effort to evaluate whether offsite sources are contributing chlorinated-VOC impact to the ground water, existing monitoring wells at the east adjacent gas station will be sampled concurrently with the onsite monitoring wells.	Ground water samples will be analyzed for TPHd, TPHg, TPHo, VOCs, CA Title 22 metals, and PAHs.	
5.5.3 Area West of Mobile Equipment Shop		
• One soil boring will be advanced and continuously sampled to the water table, where a grab ground water sample will be collected, in the area of the former 1,000-gallon Diesel UST. • One direct push soil boring will be advanced and continuously sampled to the water table, where a grab ground water sample will be collected, north of the geophysical survey area. • Two soil borings will be advanced and continuously sampled to the water table, where grab ground water samples will be collected, west of the geophysical survey area.	Soil and ground water samples will be selectively analyzed for TPHd, TPHo, TPHg, VOCs, CA Title 22 metals, ethylene glycol (selected ground water samples only), and PAHs.	Based on the soil and ground water analytical data, locations may be selected for ground water monitoring wells, which will be screened from 5 to 15 feet bgs.

APPENDIX A-2 TABLE 5 (AME 2005b)

PROPOSED SAMPLING AND ANALYSIS SUMMARY
Georgia-Pacific California Wood Products Manufacturing Facility
90 West Redwood Avenue, Fort Bragg, California

Sampling	Analysis	Further Action
• One soil boring will be advanced and continuously sampled to the water table, where a grab ground water sample will be collected, to the southwest of soil boring SB-1 to evaluate the extent of COPC impact.		
5.5.4 Transformer Pad		
• Four direct push soil borings will be advanced and continuously sampled to the water table in the vicinity of previous sample P5-14 (located near the northeast corner of the pad).	Two soil samples from each soil boring will be analyzed for TPHo using EPA Method 8015 and PCBs.	
5.5.5 Fuel Storage and Dispenser Building		
• Four direct push soil borings will be advanced and continuously sampled to the water table, where grab ground water samples will be collected, beneath the former AST locations (one soil boring for each AST). • Eight additional soil borings will be advanced and continuously sampled to the water table, where grab ground water samples will be collected, at the perimeter of the area where petroleum impact was reported. – Two soil borings east and southwest of soil boring P5-35. – One soil boring south of soil boring P5-36. • Five soil borings in the vicinity of soil boring P5-34 and monitoring well MW-5.5 (three of these borings were described in Section 5.5.1.3 and will also serve to investigate the Truck Wash Pit).	Soil and ground water samples will be analyzed for TPHd, TPHo, TPHg, VOCs, lead, and PAHs to evaluate subsurface conditions.	Additional soil borings may be added to the program based on the findings from the initial sample analyses.

APPENDIX A-2 TABLE 5 (AME 2005b)

PROPOSED SAMPLING AND ANALYSIS SUMMARY
Georgia-Pacific California Wood Products Manufacturing Facility
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Sampling	Analysis	Further Action
5.5.6 Tire Shop		
• One direct push soil boring will be advanced and continuously sampled to the water table, where a grab ground water sample will be collected, approximately 50 feet west of soil boring P5-37. • One direct push soil boring will be advanced and continuously sampled to the water table, where a grab ground water sample will be collected, approximately 100 feet west of monitoring well MW-5.3.	Soil and ground water samples will be selectively analyzed for TPHd, TPHg,TPHo, VOCs, CA Title 22 metals, ethylene glycol (selected ground water samples only), and PAHs.	Locations for one or two monitoring wells will be selected based on review of the ground water analytical data.
5.5.7 Fill Area at Log Pond		
• A geophysical survey of the Log Pond East Fill Area to (1) characterize the extent of the fill area; (2) identify areas of buried metal and other debris; (3) identify areas of elevated soil conductivity that may suggest the presence of soil COPC impact. The geophysical survey will use both ground conductivity and time domain electromagnetic metal (TDEM) detector surveys. The ground conductivity survey will use the Geonics EM-31, which uses electromagnetic induction to measure the ground conductivity. The Geonics EM-61 will be used for the TDEM detector survey to detect buried metallic objects. Both instruments will be operated in automatic data acquisition mode and record data in a data logger along 10-foot-interval survey lines. Survey data locations will be obtained simultaneously using a global positioning system (GPS) unit rated to sub-meter accuracy, with the location data recorded in a data logger. • Fifteen direct push soil borings will be advanced and continuously sampled until native material is encountered; also, grab ground water samples will be collected at each location. – Soil borings will be located in the area bounded by monitoring well MW-5.6, the geophysical survey area, Pond 5, and the Log Pond.	Soil and ground water samples will be selectively analyzed for TPHd, TPHo, VOCs, CA Title 22 metals, PCBs (selected samples), dioxins and furans (selected samples), and PAHs based on field observations.	

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Sampling	Analysis	Further Action
5.5.8 Former Oil House		
• Two direct push soil borings will be advanced and continuously sampled to the water table, where grab ground water samples will be collected, at the Former Oil House.	Soil and ground water samples will be selectively analyzed for TPHd, TPHo, VOCs, CA Title 22 metals, and PAHs.	Additional soil borings may be completed to further assess the extent of soil and ground water impact based on a review of the initial chemical data.
5.5.9 Former Open Refuse-Fire, Engine House, and #5 Shingle Mill		
• Two soil borings will be advanced and continuously sampled to the water table, where grab ground water samples will be collected, in the Former Open Refuse-Fire Area. – If soil borings cannot be located within the proposed area due to equipment access restrictions, they will be relocated nearby as feasible. • Two soil borings will be advanced and continuously sampled to the water table, where grab ground water samples will be collected, in the Former Engine House Area north of the existing berm (the area south of the berm may be inaccessible to drilling equipment). • Two soil borings will be advanced and continuously sampled to the water table, where grab ground water samples will be collected, in the Former Number 5 Shingle Mill Area.	Soil and ground water samples will be selectively analyzed for TPHd, TPHo, VOCs, CA Title 22 metals, dioxins and furans (selected samples at the Open Refuse-Fire Area), and PAHs.	
5.6 Parcel 6		
5.6.1 Former Hazardous Waste Storage Area		
• Two soil borings will be advanced and continuously sampled to the water table, where grab ground water samples will be collected, interior of the building (near previous soil boring P6-1).	Soil and ground water samples will be analyzed for TPHd, TPHo, VOCs, CA Title 22 metals, PAHs, and PCBs.	Additional soil borings may be completed based on chemical data from the initial soil borings.

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Sampling	Analysis	Further Action
• Three soil borings will be advanced and continuously sampled to the water table, where grab ground water samples will be collected, exterior of the building (near pothole P6-PH3).		
5.6.2 Planer #2		
• Two soil borings will be advanced and continuously sampled to the water table, where grab ground water samples will be collected, near previous soil boring P6-3 to evaluate soil and ground water impact by petroleum hydrocarbons. • Two soil borings will be advanced and continuously sampled to the water table, where grab ground water samples will be collected, exterior of the building north and south of soil boring P6-10 to assess the extent of soil TPHd impact. • Two soil borings will be advanced and continuously sampled to the water table, where grab ground water samples will be collected, north of the building in the area of the former compressor house. • Two soil borings will be advanced and continuously sampled to the water table, where grab ground water samples will be collected, at the former dispenser and UST area near the northeast building corner.	Soil samples will be selectively analyzed for formaldehyde using EPA Method 8315, and ground water samples will be selectively analyzed for TPHd, TPHo, VOCs, phenol, pentachlorophenol, tetrachlorophenol, dioxins and furans (where pentachlorophenol is detected), DDAC, propiconazole, CA Title 22 meals, and PAHs. Samples from the former UST and dispenser location will additionally be analyzed for TPHg.	Other soil boring locations may be added to the program based on a visual survey of areas containing sumps, floor cracks, surface staining, or other environmentally pertinent features.
5.6.3 Former Truck Shop		
• Three direct push soil borings will be advanced and continuously sampled to the water table, where grab ground water samples will be collected, in the Former Truck Shop Area.	Soil and ground water samples will be selectively analyzed for TPHg, TPHd, TPHo, VOCs, CA Title 22 metals, ethylene glycol (selected ground water samples only), and PAHs.	Additional soil boring locations may be added based on the analytical data from the initial three soil borings.

APPENDIX A-2 TABLE 5 (AME 2005b)

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Sampling	Analysis	Further Action
5.6.4 Former Vehicle Maintenance Shop (Shipping Office)		
• The 6-by-12-foot GPR anomaly located approximately 60 feet north and 10 feet east of the northeast building corner will be excavated to assess its nature. • Eight soil borings will be advanced and continuously sampled to the water table, where grab ground water samples will be taken, in the Former Vehicle Maintenance Shop, Oil House, and Number 8 Fiber Plant Areas. – Four soil borings will be advanced in the area of previous soil borings P6-12 and P6-14 to evaluate the extent of COPC soil impact reported in samples from those soil borings. – Two soil borings will be advanced in the area of the Former Oil House, based on the location shown on the 1960s facility map. • Two soil borings will be advanced in the area of the Former Number 8 Fiber Plant to investigate potential soil impact from historical operations at that facility.	Soil and ground water samples will be selectively analyzed for TPHd, TPHg, TPHo, VOCs, PAHs, CA Title 22 metals, and ethylene glycol (selected ground water samples only).	Additional soil borings may be advanced based on a review of the initial analytical data. Additional soil borings may be advanced based on a review of the initial analytical data.
5.6.5 Former Aboveground Storage Tank		
• Four direct push borings will be advanced in a square array centered on previous soil boring P6-15 and continuously sampled to the water table, where grab ground water samples will be collected.	Soil and ground water samples will be analyzed for TPHd, TPHo, PAHs, and CA Title 22 metals.	Additional boring locations may be selected based on a review of the initial analytical data.

APPENDIX A-2 TABLE 5 (AME 2005b)

PROPOSED SAMPLING AND ANALYSIS SUMMARY
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Sampling	Analysis	Further Action
5.6.6 Fill Area		
• A geophysical survey – A ground conductivity survey consisting of a Geonics EM-31 using electromagnetic induction to measure ground conductivity – A TDEM detector survey using the Geonics EM-61 to detect buried metallic objects – Instruments will be operated in automatic data acquisition mode and record data in a data logger along 10-foot-interval survey lines. – Survey data locations will be obtained simultaneously using a GPS unit rated to sub-meter accuracy, with the location data recorded in a data logger. • Three potholes or large-diameter borings to evaluate the nature of the fill.	Soil and ground water samples taken from these three locations and analyzed for TPHd, TPHo, VOCs, PAHs, dioxins and furans (selected samples), PCBs (selected samples), and CA Title 22 metals.	Based on a review of the soil and ground water data, approximately three ground water monitoring wells will be screened from 5 to 15 feet bgs and continuously soil sampled to total depth during drilling to evaluate ground water conditions across the area.
5.7 Parcel 7		
5.7.1 Hazardous Materials Storage Area		
• Three soil borings will be advanced east, west, and south of soil boring P7-1 and continuously sampled to the water table (anticipated at approximately 7 feet bgs), and grab ground water samples collected, to evaluate the extent of soil TPHd impact reported at soil boring P7-1.	Soil and grab ground water samples will be selectively analyzed for TPHo using EPA Method 8015, TPHd, VOCs, CA Title 22 metals, and PAHs.	

APPENDIX A-2 TABLE 5 (AME 2005b)

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Sampling	Analysis	Further Action
5.7.2 Beehive Burner and Fuel Aboveground Storage Tanks		
• Two soil borings will be advanced and continuously sampled to the water table, where grab ground water samples will be collected, north and northwest of previous soil borings P7-10 and P7-11.	Soil and ground water samples will be selectively analyzed for TPHo using EPA Method 8015, TPHd, VOCs, dioxins and furans (selected samples), CA Title 22 metals, and PAHs.	A map plotting the findings of the geophysical survey along with the previous and new soil boring locations will be submitted with the investigation report as requested by RWQCB.
5.7.3 Diesel Tank, Generator, Pump, and South Ponds		
• Three direct push soil borings (one for each feature: Diesel AST, Pump, and Generator) will be advanced and continuously sampled to the water table, where grab ground water samples will be collected, to investigate the equipment area north of Pond 2.	Soil and ground water samples will be selectively analyzed for TPHd, TPHo, VOCs, and PAHs.	
• Sediment samples will be collected using two soil borings performed at each pond using the following general procedure. – The sampling location will be land surveyed using GPS equipment. – The water depth will be measured at each sampling location using a weighted tape measure. – Sediment thickness at each location will be measured using a sediment probe manually pushed into the sediment. – An appropriate sediment sampling device will be selected based on the sediment thickness at each sampling location. – Sediment samples will be retained from the top of the sediment and at no greater than 5-foot intervals thereafter in order to characterize the full sediment thickness.	Samples will be analyzed for VOCs, TPHd, TPHo, PAHs, CA Title 22 metals, Cr VI, dioxins and furans (selected samples), cyanide, and PCBs (selected samples).	

APPENDIX A-2 TABLE 5 (AME 2005b)

PROPOSED SAMPLING AND ANALYSIS SUMMARY
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Sampling	Analysis	Further Action
• A surface water sample will be collected near the sediment-water interface at each sediment sampling location to evaluate the interaction between the water and underlying sediment.	Surface water samples will be field-filtered and analyzed for CA Title 22 metals.	Based on the results of the associated sediment sample analyses, an additional surface water sample may be collected at a later date for the analysis of COPCs reported in the sediment sample.
5.7.4 Existing Water Supply Well Abandonment		
• Inspection of each well to assess its status and condition • Overdrilling and removal from the subsurface of well casings using hollow-stem auger equipment • Backfilling with neat cement to the total depth of each resulting hole using a tremie pipe		
5.7.5 Soil and Ash Stockpiles		
• Two samples of the Soil Stockpile.	Samples will be analyzed for TPHo using EPA Method 8015, TPHg, TPHd, VOCs, PAHs, and lead for disposal characterization.	
• Two samples of the Ash Stockpile.	Samples will be analyzed for dioxins and furans (selected samples), PAHs, and CA Title 22 metals for disposal characterization.	

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Sampling	Analysis	Further Action
• A waste disposal manifest will be completed for offsite disposal of both Stockpiles at a Class II landfill if chemical concentrations are within acceptable limits.		A certified waste hauler will be used to transport the soil and ash to the disposal facility.
5.8 Parcel 8		
5.8.1 Airstrip Fueling Area		
• Two soil borings will be advanced and continuously soil sampled to the water table, where grab ground water samples will be collected, near the center of each former building (based on the locations depicted in the aerial photograph).	Soil and ground water samples will be selectively analyzed for TPHg, TPHd, VOCs, and lead.	
5.8.2 Fill Area (Disturbance Along Coastal Region)		
• Geophysical survey of the area to evaluate the extent of fill materials and identify potential rail lines.		Based on survey results, locations will be selected and excavated using a backhoe or large-diameter auger to evaluate potential geophysical anomalies and lateral and vertical fill extent. Previous investigations indicate the potholes will begin in the vicinity of previous potholes P8-T2 and P8-PH6 and proceed radially outward (two potholes excavated in Parcel 8 are designated P8-PH6: one at the clinker piles excavated on

PROPOSED SAMPLING AND ANALYSIS SUMMARY
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Sampling	Analysis	Further Action
		March 17, 2003 for the Phase II investigation and another in the Coastal Disturbance Area excavated on July 20, 2004 for the additional site assessment).
• Potholes will be advanced and soil sampled to native material to assess vertical fill extent (ground water sampling in this area is not anticipated).	Soil samples will be selectively analyzed for TPHd, TPHo, dioxins and furans (selected samples), CA Title 22 metals, PCBs (selected samples), VOCs, and PAHs.	
5.8.3 Clinker Piles		
• Ten soil borings or potholes (depending on equipment accessibility) will be completed to approximately 5 feet bgs. At least one clinker and one soil sample will be collected at each location.	Soil and clinker samples will be analyzed for dioxins and furans (selected samples), CA Title 22 metals, and PAHs.	Evaluation of disposal and treatment options to decide the final disposition of the clinker material will be accomplished after reviewing the laboratory data.
5.9 Parcel 9		
• Two soil borings will be advanced and continuously sampled to the water table, where grab ground water samples will be collected, to evaluate soil and ground water conditions near the sump located in the greenhouses east of the Chemical Mixing Shed.	Soil and ground water samples will be selectively analyzed for pesticides and nitrate, as listed in Table 1.	

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Sampling	Analysis	Further Action
• Seven step-out soil borings will be advanced and continuously sampled to the water table, where grab ground water samples will be collected, at the perimeter of the area where pesticides were reported in soil and ground water samples. • A phased sample analysis approach will be used to detect Nursery COPCs (Table 1) in samples collected near the sump. The results of these analyses will determine target-analyte lists for subsequent samples collected at additional locations.		
5.10 Parcel 10		
• Ten borings or potholes will be advanced at the piles to approximately 10 feet bgs to characterize chemical concentrations in stockpile and underlying soil samples. – Sample locations will be chosen randomly from a systematic grid overlay at a spacing of approximately 15 feet.	Samples will be analyzed for TPHd, TPHo, VOCs, dioxins and furans, PCBs, PAHs, and CA Title 22 metals.	Analytical data will be reviewed to evaluate options for the long-term disposition of the waste materials, which may include onsite treatment or offsite transport and disposal at an appropriate facility.
5.11 Pond 8 and Storm Drain		
5.11.1 Pond 8		
• Surface water sample collection at outfall. – The water sample location upstream of the outfall to the ocean will be accessed by a small boat or on foot within an area where bottom sediments have not been disturbed.	The sample will be tested for VOCs, TPHg, TPHd, TPHo, PAHs, CA Title 22 metals, cyanide, and Cr VI.	
• Sediment samples will be collected using four soil borings performed at equally spaced intervals along the axis of the pond using the following general procedures. – The sampling location will be land surveyed using GPS equipment.	Samples will be analyzed for VOCs, TPHg, TPHd, TPHo, PAHs, CA Title 22 metals, Cr VI, dioxins and furans (selected samples), cyanide, and PCBs.	

PROPOSED SAMPLING AND ANALYSIS SUMMARY
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Sampling	Analysis	Further Action
– The water depth will be measured at each sampling location using a weighted tape measure. – Sediment thickness at each location will be measured using a sediment probe manually pushed into the sediment. – An appropriate sediment sampling device will be selected based on the sediment thickness at each sampling location. – Sediment samples will be retained from the top of the sediment and at no greater than 5-foot intervals thereafter in order to characterize the full sediment thickness. Lithologic data from borings near the shoreline will be used to correlate sediment thickness and depth of nearby fill to characterize actual sediment thickness.		
• A surface water sample will be collected near the sediment-water interface at each sediment sampling location to evaluate the interaction between the water and underlying sediment.	Surface water samples will be field-filtered and analyzed for CA Title 22 metals.	Based on the results of the associated sediment sample analyses, an additional surface water sample may be collected at a later date for the analysis of COPCs reported in the sediment sample.
5.11.2 Storm Drain		
• Surface water sample collection. – If there is adequate water volume, samples will be obtained from the storm drain by immersing sampling containers directly into the water without disturbing bottom sediments. If there is inadequate water depth to immerse the containers, then water can be transferred into them from a clean sampling cup.	Surface water samples will be analyzed for VOCs, TPHg, TPHd, TPHo, PAHs, CA Title 22 metals, and Cr VI.	

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Sampling	Analysis	Further Action
• Sediment sample collection. – Sediment samples can be obtained by pressing a clean stainless-steel sampling tube directly into the media to be sampled. If necessary, a slide hammer can be used to imbed the sample tube.	Sediment samples will be analyzed for VOCs, TPHg, TPHd, TPHo, PAHs, CA Title 22 metals, Cr VI, dioxins and furans, cyanide, and PCBs.	
5.12 Roadways		
• A GPS survey will be conducted to verify the roadway locations and help determine sampling locations. • Samples of surface soil will be collected at four locations judged likely for roadway dust suppression. – Three samples will be collected at each location at approximately 50-foot intervals along the lines of the former roadways. – Samples will be collected beneath existing asphalt pavement, where present, to characterize surface soils and gravel roadways that were subsequently paved. – Proposed locations include roadways in the following areas: ▪ Finished lumber product storage (Parcel 1) ▪ Vicinity of the Helicopter Pad (Parcel 2) ▪ South end of the runway, near the Aircraft Fueling Area (Parcel 8) ▪ Roadway between the Powerhouse and Sawmill #1 (Parcel 4)	Soil samples will be analyzed for TPHo, VOCs, PAHs, CA Title 22 Metals, and PCBs.	
5.13 Monitoring Well Installation and Ground Water Monitoring		
• Ground water monitoring wells will be considered at the following locations based on a review of soil and grab ground water data from initial sampling as discussed in Sections 5.1 through 5.3, 5.5, and 5.6: – Pump House (Parcel 1) – Resaw #5, Glue Lam Building, and Helicopter Landing Pad (Parcel 2) – Former Planer #1 and Former Mobile Equipment Shop (Parcel 3)		Ground water monitoring wells may be planned at other locations depending on an evaluation of grab ground water sample chemistry for soil borings completed in each area.

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PROPOSED SAMPLING AND ANALYSIS SUMMARY
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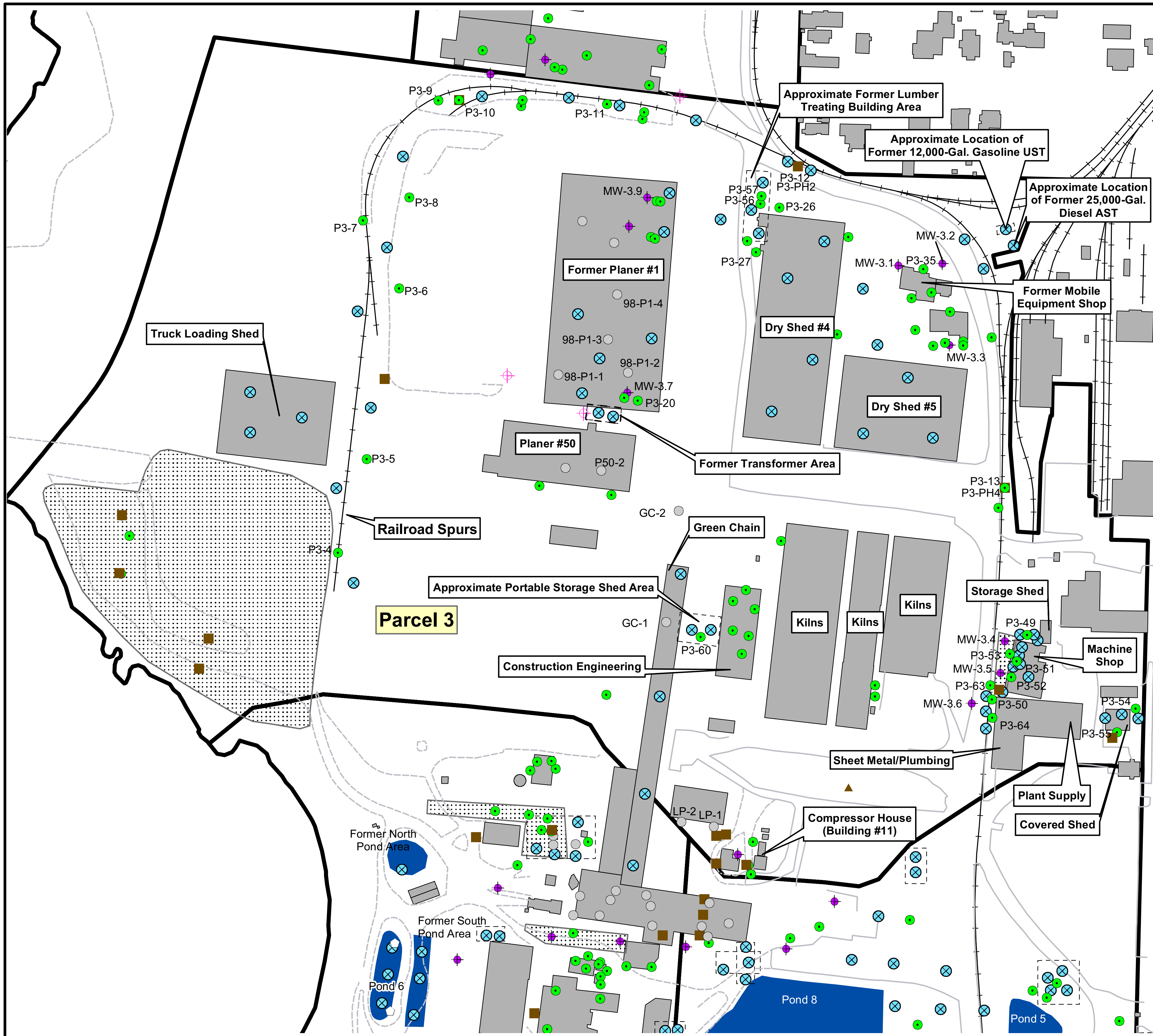
Sampling	Analysis	Further Action
– Mobile Equipment Shop and Area West of the Mobile Equipment Shop (Parcel 5) – Log Pond West Fill Area (Parcel 6) • Two sets of paired ground water monitoring wells and piezometers will be installed at the site (one set on Parcel 3 and one set on Parcel 5): – Monitoring wells will be screened at first-encountered ground water. – Piezometer soil borings will be drilled within 10 feet of the monitoring wells and installed using 8-inch-diameter hollow-stem auger equipment. ▪ The piezometers will extend to the top of bedrock and are intended to provide information on vertical ground water flow conditions. ▪ Soil borings will be advanced until bedrock is encountered and sampled at 5-feet-bgs intervals for logging purposes and to confirm stratigraphy encountered in the monitoring wells. ▪ When the soil borings have reached total depth, 2-inch-diameter, Schedule 40 PVC casing will be installed. ▪ Five feet of screen casing will be installed at the bottom of the piezometer followed by blank PVC casing to the surface. ▪ The piezometer screen slot size will be 0.020 inch and the filter pack and bentonite and cement seals will be installed as described for the monitoring wells.		completed in each area.



Legend

- Monitoring Well Location and Designation
- Borehole Location and Designation
- Direct Push Sample Location and Designation
- Surface Sample Location
- Trench Sample Location and Designation
- Pond Sample Location
- Proposed Monitoring Well Location
- Proposed Soil Boring Location
- Pond
- Facility Structure
- Parcel Boundary
- Railroad Track
- Unpaved
- Pavement
- Historical Geophysical Survey Area

Notes:
1. All locations and dimensions are approximate.
2. Historical sampling location labels on the figure designate only locations that are discussed in the Work Plan for this parcel.

N

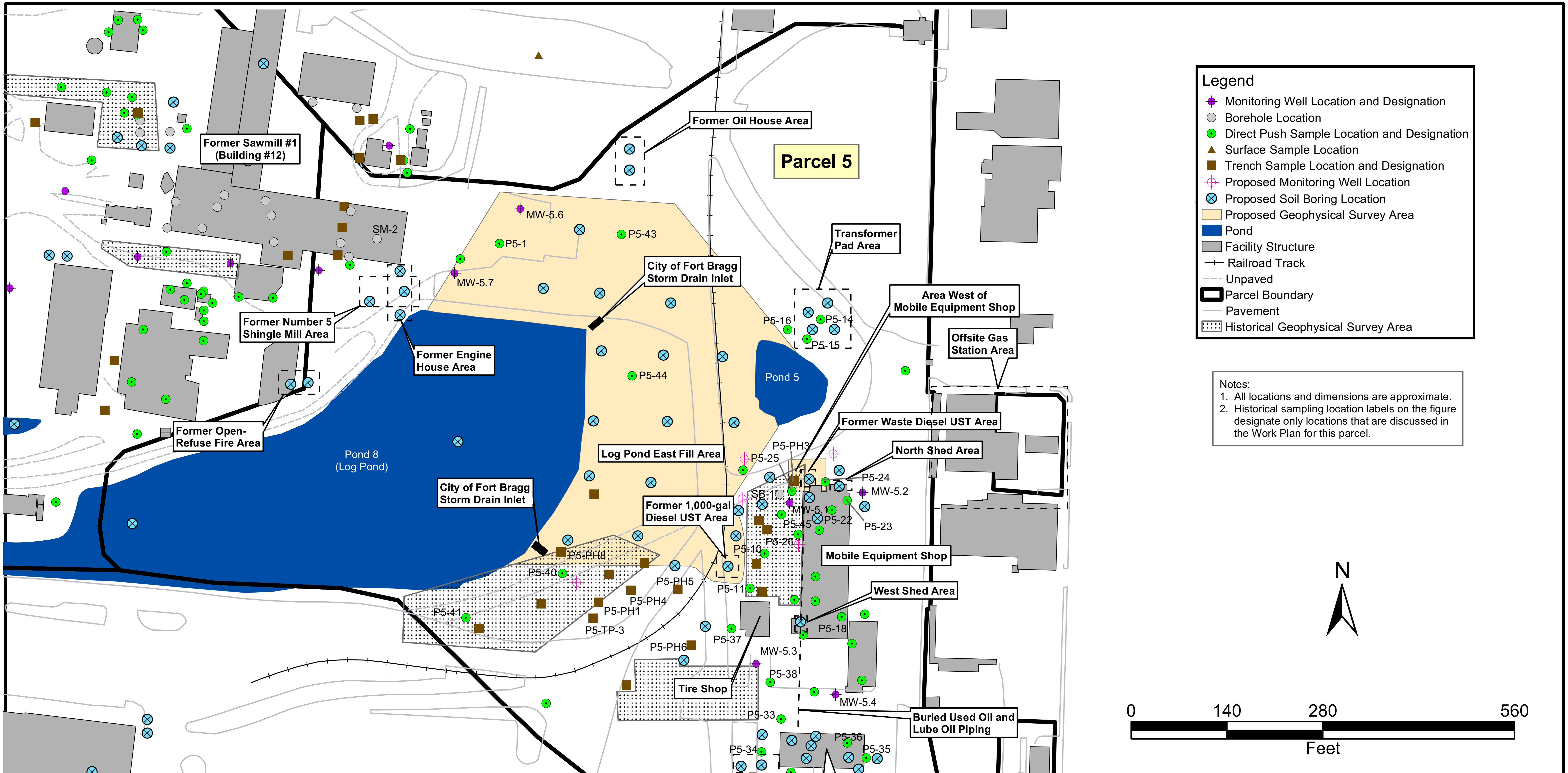
0 200 400 800
Feet

APPENDIX A-3 FIGURE

PARCEL 3
PROPOSED SOIL BORING/MONITORING WELL LOCATIONS

Georgia-Pacific California Wood Products Manufacturing Facility
90 West Redwood Avenue, Fort Bragg, California

Project No.	Drawn By AAC	Acton Mickelson Environmental, Inc.
Map File 1601707-003	Prepared By MWC	
	Reviewed By MAA	
Revison/Date 1 - 8/9/05	Scale As Noted	



APPENDIX A-3 FIGURE

PARCEL 5
PROPOSED SOIL BORING/MONITORING WELL LOCATIONS

Georgia-Pacific California Wood Products Manufacturing Facility
90 West Redwood Avenue, Fort Bragg, California

Project No.	Drawn By AAC	Acton Mickelson Environmental, Inc.
SPIRI Map File	Prepared By MWC	
	Reviewed By MAA	
Revison/Date	Scale As Noted	

APPENDIX B

RBSC DEVELOPMENT

APPENDIX B-1

DRAFT
DEVELOPMENT OF RISK-BASED SCREENING CRITERIA

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1.0 INTRODUCTION

The Georgia-Pacific California Wood Products Manufacturing Facility (GPCWPMF, Site) is located at 90 West Redwood Avenue in Fort Bragg, California. The 445-acre Site is located west of Highway One and is bound by open coastline to the north, Noyo Bay to the south, the City to the east, and the Pacific Ocean to the west.

Sawmill operations reportedly began at the Site in 1885. Georgia-Pacific (GPC) acquired the property and began operations in 1973. On August 8, 2002, lumber production operations ceased. Operations typically consisted of receiving logs by truck, followed by on-site storage, debarking, and milling. Milled lumber was then either shipped green, kiln dried, or air-dried on site. Finished lumber was transported by rail or flatbed trailers. Bark and wood refuse was transported by truck, conveyer, or pneumatic system to the power plant where it was burned to generate steam for electricity. Other operational portions of the Site included the sawmills (#1 and #2), planer buildings, fence plant, power plant, lumber storage areas, various maintenance facilities, and a seedling nursery.

Based on operational characteristics, the Site has been divided into 10 parcels, including parcels where the power plant, nursery, and other operations were located. In March and June 2005, GPC submitted two workplans (Acton Mickelson Environmental [AME], 2005a,b) to conduct additional investigations. One workplan involves the potential removal of building foundations, debris, and possibly materials within geophysical anomalies found on various parcels of the Site. As part of this process, additional soil and possibly groundwater samples will be collected for verification purposes. The second workplan involves investigations outside of the areas requiring approval as part of the coastal development permit. Both sets of sampling results, however, will be examined to determine whether constituents in soils or groundwater (if applicable) exceed screening levels and whether interim remedial measures (IRMs) or additional investigation should be conducted.

This appendix describes the steps used to develop risk-based screening criteria (RBSCs) protective of human health and the environment. Soil and groundwater RBSCs were developed to assist in Site characterization by identifying chemicals and/or areas requiring additional evaluation (e.g., further characterization or removal). RBSCs are not intended as chemical concentrations that are acceptable to remain in soil or groundwater. The process used to develop these screening levels will be reviewed by the Office of Environmental Health Hazard Assessment (OEHHA) (consultant to the North Coast Regional Water Quality Control Board [RWQCB]). The whole process is directed at achieving a reasonable protection of human health and ecological resources of concern at the Site.

RBSCs are chemical-specific concentrations that result in a specified level of risk or health hazard. RBSCs were developed using a seven-step procedure, as follows:

Step 1: Approach for identifying chemicals of potential concern (COPCs)
Step 2: Identify types of receptors
Step 3: Identify potentially complete exposure pathways
Step 4: Specify approach for quantifying exposures
Step 5: Specify toxicity sources to be used for developing risk-based criteria
Step 6: Identify target risk or hazard quotient (HQ)
Step 7: Describe risk characterization and uncertainty analysis

The factors used to address each of these steps are described below. The initial evaluation step that includes identification of chemicals of potential concern (COPCs) in soil will apply to the RBSC-development process for both the human and ecological receptors at this Site. This is considered reasonable at this time because sampling to-date has been conducted exclusively in terrestrial environments or in groundwater. Also, although surface water and sediments have not been sampled at the Site, sampling is planned for these environmental media. It is anticipated that biological receptors will be most likely to be exposed to surface water and sediments and, therefore, this set of COPCs will be addressed by the ecological risk screening process. Separate evaluation procedures are presented below for developing these and other aspects of the human health and ecological risk-based screening criteria.

2.0 APPROACH FOR IDENTIFYING CHEMICALS OF POTENTIAL CONCERN

Chemicals of potential concern (COPCs) are chemicals that have the potential to adversely affect human health or the environment. Metals and organic compounds detected in soil and groundwater sampling conducted to date at the Site were considered in the selection of COPCs for developing RBSCs. The COPCs in soil were based on the results of the soil sampling conducted as part of the *Phase 2 Environmental Site Assessment* (ESA) (TRC 2004a) and *Additional Site Assessment* (TRC 2004b). Table B-1.1 provides a preliminary list of the chemicals detected in soil during the Phase 2 ESA (TRC 2004a).

The COPCs in groundwater were identified using the groundwater monitoring data collected quarterly during 2004 (TRC 2005) and during the 3rd quarter of 2005 (AME 2005). Chemicals detected more than once in groundwater or detected in a well with free-product were identified as COPCs. These COPCs are also listed in Table B-1.1.

To evaluate petroleum hydrocarbons, it is planned to evaluate total petroleum hydrocarbons (TPH) using a modification of the approach developed by the Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG). This modification consists of the use of project-specific carbon-chain ranges generally consistent with those of the TPHCWG (1997), with one carbon chain group extended from C21 to C24 and another from C35 to C36. Thus, six TPH groups will be evaluated, based on the standard analytical TPH (8015M) method (i.e., carbon chain groups of >C6-C8, >C8-C10, >C10-C12, >C12-C16, >C16-C24, and >C24-C36). Other details of the analytical approach are described in the “Response to RWQCB Comments on AME’s (2005b) *Work Plan for Additional Site Assessment*.” Of note for the risk analyses, the laboratory will not report separate aromatic and aliphatic fractions for these carbon chain groups. Thus, a health-protective approach is used to evaluate each group, based on the most environmentally mobile and more toxic component of each carbon chain group, as defined by the TPHCWG (1997).

The following sections of this appendix describe the procedures that were used to determine RBSCs for the COPCs identified in soil and groundwater. A brief description of the approach planned for determining RBSCs for COPCs in surface water and sediment is also provided.

3.0 DEVELOPMENT OF HUMAN HEALTH RISK-BASED SCREENING CRITERIA

3.1 Identify Potential Human Receptors

USEPA guidance (1989a) recommends characterizing risks to populations on or near a release site because these receptors may have the greatest potential for exposure to COPCs. Only one type of human receptor was used to develop RBSCs. As per discussions with OEHHA (2005), this allows the establishment of a single set of risk-based criteria that can be applied across the Site regardless of the parcel being evaluated. For this Site RBSCs were developed to be protective of future residential receptors. This is considered appropriate and health protective because:

- Current plans include development of a large portion of the Site for residential purposes;
- Future commercial properties, such as arcades, could be used regularly by residential youths; and

- Residential evaluations including both children and adult exposures to COPCs are frequently used as a basis for determining the feasibility of unrestricted site use.

3.2 Identify Potentially Complete Exposure Pathways

A conceptual site model (CSM) presents information on the sources of environmental releases and the routes by which people may be exposed to potentially toxic constituents. A CSM also integrates information on the environmental behavior of the constituents of concern to determine potentially complete exposure pathways. An exposure pathway describes the course that a chemical takes from a source to an exposed individual. An exposure pathway is considered to be complete when it has each of the following four factors:

- A source of chemical releases;
- A contaminated medium (e.g., soil);
- An exposure, or contact, point with the environmental medium (e.g., direct soil contact); and
- An exposure route through which chemical intake may occur (e.g., dermal absorption).

Designation of an exposure pathway as complete indicates that human exposure is possible but does not necessarily mean that exposure will occur nor that exposure will occur at the levels estimated in this report. When any one of the factors is missing in an exposure pathway, it is considered to be incomplete. Potentially incomplete exposure pathways are not evaluated in this evaluation.

The exposure pathways identified for developing RBSCs protective of future on-site residents include the following:

- Soil contact could result in accidental soil ingestion and dermal contact with soils.

- Chemicals may be inhaled when released to the atmosphere on windborne dusts emitted from soil.

- Groundwater is currently not used on this Site and is not likely to provide sufficient volume to be a reliable source of water. Therefore, groundwater is unlikely to represent a source of drinking water in the future. However, the RWQCB has characterized all groundwater in this area as potential municipal water sources (C. Hunt, pers. comm.). Based on this determination, groundwater use was evaluated separately to assess resource protection. Groundwater use may include consumption (ingestion), bathing that could result in dermal contact with groundwater, and inhalation of volatile chemicals emitted in the shower.

- Volatile chemicals present in both soils and shallow groundwater may be emitted from the soil surface into the atmosphere or to indoor air. These chemicals may, therefore, be inhaled by a future on-site resident. Although both exposure pathways may be complete, to be health protective, exposure to vapors in indoor air were evaluated preferentially because indoor exposures are likely to be higher than those occurring in the outdoors where volatile emissions may be substantially dispersed by atmospheric mixing.

- Volatile chemicals may potentially leach from soil to groundwater. These chemicals may, therefore, impact groundwater in the future, if not presently detected in groundwater. Based on this determination, RBSCs were developed for these chemicals, assuming residents could potentially be exposed as a result of groundwater use as a source of drinking water in the future.

The potentially complete exposure pathways selected as the basis for developing RBSCs for this Site are summarized in Figure B-1.

3.3 Approach for Quantifying Potential Human Exposures

Exposure to a chemical in an environmental medium is assumed to be proportional to the concentration of the chemical in the medium, rate of contact with the medium, and the duration of exposure. Potential exposure parameters for future residents were evaluated according to USEPA (1989a, 1991a,b, 1992, 1996, 1997a, 2002a, 2003, 2004a) and DTSC (1992, 1999, 2000a,b) guidance. A reasonable maximum exposure (RME) scenario was used to ensure that exposures integrated into the calculation of RBSCs represent the highest level of exposure that may reasonably occur, but not necessarily the worst level of exposure (USEPA 1989a). This includes use of the 90th or 95th percentile values of the majority of intake variables. RBSCs calculated on the basis of these assumed exposures are therefore likely to be highly health protective. The equations and exposure parameter used to calculate RBSCs are presented in Tables B-1.2 to B-1.6. It should be noted that RBSCs for direct soil contact (i.e., ingestion, dermal contact, and dust inhalation) are based on a combined child and adult exposure for carcinogenic chemicals, while the more health protective approach using a child's exposure was used to develop RBSCs for non-carcinogenic chemicals. For groundwater, RBSCs for carcinogens were also be based on a combination of adult and child exposures, while those for non-carcinogens were based on adult exposures because USEPA (2004a) guidance indicates that only adults are exposed to volatile chemicals via water ingestion, dermal contact during showering, and vapor inhalation during showering.

3.3.1 Environmental Fate and Transport Modeling

In order to assess the potential chemical concentrations that receptors could be exposed to due to inter-media transfer and transport, the effects of chemical fate and transport processes were included in the evaluation of RBSCs. Inter-media transfer is the movement of chemicals between environmental media such as soil and air. Chemical transport occurs through the movement of an environmental medium by natural advective and dispersive processes such as air dispersion. Of particular concern at the Site is the migration of volatile COPCs through soil pores upward from soil or groundwater to the ground surface and downward from soil to the water table. At the ground surface, volatile chemicals can be released as vapors to indoor air. At the water table, volatile chemicals can mix with groundwater.

The specific processes that considered in these evaluations include:

- Dust emissions from soils and mixing in the atmosphere.
- Vapor emissions from soils and intrusion into indoor air.
- Vapor emissions from groundwater and intrusion into indoor air.
- Volatile chemical mixing with groundwater

Modeling to be conducted for these indirect exposure pathways was addressed using a screening approach to ensure highly protective RBSCs, both related to indoor vapor intrusion from soils and groundwater (as per OEHHA [2005] recommendations) and for volatile chemical dissolution in groundwater (see also Attachment B-2).

Respirable dust. Respirable dust particles are comprised of particulate matter 10 microns or less in diameter (PM_{10}). Nonvolatile chemicals can sorb to soils and become airborne dusts through the erosion of soils by the wind. The chemical fraction in dust is assumed to be the same as the chemical fraction in the soil. The airborne PM_{10} chemical concentration is estimated as follows:

$$C_a = \frac{C_s}{PEF}$$

where:

C_a	=	chemical concentration in airborne dust (mg/m^3)
C_s	=	chemical concentration in soil (mg/kg)
PEF	=	particulate emissions factor (m^3/kg)

A particulate emission factor (PEF) was calculated according to USEPA (1996, 2002a) guidance.

The ambient airborne concentrations, $C_{air}^{predicted}$, of chemicals on PM_{10} were calculated according to USEPA (1996, 2002) guidance as follows:

$$C_{air}^{predicted} = \frac{E}{Q/C} \times 10^6 \, mg/kg$$

where

C_{air}	=	airborne dust concentration (mg/m^3)
E	=	chemical emission rate (g/m^2/s)
Q/C	=	dispersion factor [(g/m^2/s)/(kg/m^3)]

The USEPA (1996, 2002a) has calculated dispersion coefficients (Q/C) using the Industrial Source Complex (ISC) model for a number of metropolitan areas in the United States. The Q/C factor determined by the USEPA for a source area in San Francisco (the closest metropolitan area to Fort Bragg) comparable in size to 0.5 acre was used in the derivation of the RBSCs.

Vapors. Volatile chemicals are defined as those chemicals having a Henry's Law constant greater than 10^{-5} (atm-m^3/mol) and a molecular weight less than 200 g/mole. Since RBSCs for volatile chemicals are based on indoor vapor intrusion, intrusion was evaluated using the Johnson and Ettinger indoor air model (USEPA 2003) as modified by Cal EPA (2005). The infinite source version of the Johnson and Ettinger indoor air model was used to model migration of chemicals from soil and groundwater to indoor air at the Site. The model incorporates both convective and diffusive mechanisms that drive vapor intrusion rates, and also accounts for subsurface soil and building properties. The model provides a conservative estimate of vapor intrusion given uncertainties in modeling volatile contaminants partitioning from subsurface soil and groundwater, diffusing through the vadose zone, and migrating through concrete foundations into building air. In recent years, there are a number of published studies that have continued the validation of the indoor air models (DeVaull et al. 2002; Hers et al. 2002). General conclusions from these studies are that the models often over predict concentrations of aromatic hydrocarbons such as benzene, by one to two orders of magnitude, because biodegradation is not considered. The models show reasonable agreement for chlorinated solvent predictions. Based on these considerations, therefore, the RBSCs for indoor vapors are likely to be highly health protective.

3.3.2 Use of Model Results

The following linear relationship was used to calculate RBSCs based on the modeling results:

$$\frac{\text{RBSC}_{(\text{soil or water})}}{\text{Acceptable Concentration}_{(\text{indoor air})}} = \frac{\text{Unitary Source Term}_{(\text{soil or water})}}{\text{Predicted Concentration}_{(\text{indoor air})}}$$

This equation can be re-arranged to calculate RBSCs for each COPC as follows:

$$\text{RBSC}_{(\text{soil or water})} = \frac{\text{Acceptable Concentration}_{(\text{indoor air})}}{\text{Predicted Concentration}_{(\text{indoor air})}}$$

Acceptable indoor air concentrations were calculated using the same parameters used for estimating exposures. The equations for estimating acceptable concentrations for indoor air are shown in Table B-1.6.

RBSCs were calculated separately for each exposure pathway and combined to determine overall RBSCs. The combination process is described in Section 3.6.4.

3.4 Human Health Toxicity Assessment

The potentially toxic effects, both carcinogenic and non-carcinogenic effects, of the COPCs were considered in the fifth step of determining RBSCs protective of future onsite residents. The toxic effects of the COPCs were estimated by using toxicity assessments published by the California Environmental Protection Agency (Cal EPA) and the USEPA.

The measures of toxic effects are specified as slope factors (SFs) for probable or possible carcinogens and chronic reference doses (RfDs) for non-carcinogenic health effects. Slope factors are used for estimating the individual upperbound excess lifetime cancer risks associated with various levels of lifetime exposure to potential human carcinogens. In practice, SFs (expressed in units of $(\text{mg/kg/day})^{-1}$) are derived from the results of human epidemiology studies or chronic animal bioassays. Toxicity values for non-carcinogens are based on a threshold level of exposure and are defined as an estimate of the maximum daily exposure that will not produce an appreciable risk of adverse health effects during a lifetime. For this report, the Cal EPA (2005) slope factors were used preferentially, unless a Cal EPA slope factor is not available, in which case an USEPA (2005) slope factor were used. Non-carcinogenic RfDs were obtained from the USEPA (2005), if available. If no toxicity values were available from these sources, the following secondary sources were consulted, as per USEPA (2003b) guidance: (1) the USEPA (1997b) Health Effects Assessment Toxicity Tables (HEAST), (2) USEPA Region 9 (2004b), Preliminary Remediation Goals (PRGs), and (3) other Cal EPA sources, such as the Public Health Goals (PHGs). The toxicity data used in calculating RBSCs are provided in Attachment B-3.

The protocol that was used to assess potential health effects resulting from exposure to lead differed from those for other chemicals. In compliance with USEPA and Cal EPA guidance, lead exposures were evaluated in terms of potential blood lead (Pb) concentrations (micrograms [µg]-Pb per deciliter [dL]-blood). This is necessary because lead exposure is typically expressed in terms of blood-lead concentrations rather than as intake or absorbed doses (i.e., mg/kg/day). Potential lead exposure analyses were carried out using a spreadsheet application (LeadSpread v7.0) developed by the State of California (DTSC 2000b). This spreadsheet integrates data on lead concentrations in soil, drinking water, air, and airborne dust and estimates the distributional pattern of blood-lead levels in potentially exposed receptors.

3.5 Identification of Target Risks

Risk-based screening criteria (RBSCs) are chemical-specific soil or groundwater concentrations that result in a specific carcinogenic or non-carcinogenic risk. Target risk levels were determined according to USEPA (1990, 1991a) and DTSC (1992, 1999) guidance. Risk-based concentrations were developed for a residential use scenario at a target risk level of 1 chance in 100,000 (1×10^{-5}). This target risk is the middle of the range (1 in 10,000 to 1 in 1,000,000 or 1×10^{-4} to 1×10^{-6}) that the USEPA considers to be both safe and protective of public health. It is also consistent with the Air Toxics “Hot Spots” Information and Assessment Act and the Safe Drinking Water and Toxic Enforcement Act (Proposition 65) policy that accepts remedial actions based on a risk of 1×10^{-5}. Also, as discussed in Section 3.6, use of RBSCs for evaluating samples with multiple detected chemicals will essentially result in a lower target risk level per chemical and will be consistent with recommendations provided by OEHHA for this Site (March 2005).

Non-carcinogenic health effects are determined by estimating the ratio between the level of exposure for each exposure pathway and each chemical-specific reference dose. This ratio is considered to be a hazard quotient (HQ), whereas the sum of the HQs for all exposure pathways is defined as a hazard index (HI). Health-protective RBSCs were developed using a target hazard index (HI) of 1 for each of the non-carcinogenic COPCs. According to the USEPA (1990), HIs less than 1 do not warrant action. For each COPC, health protective RBSCs were developed for both the cancer and non-cancer endpoints, as appropriate.

RBSCs protective of residents and groundwater were calculated using the exposure parameters and chemical toxicity data described in Sections 3.3 and 3.4. The equations provided by the USEPA (1989a) for calculating risks were rearranged (as per USEPA 1991a) to solve for the chemical concentration in soil and groundwater that would result in a specified target risk.

3.6 Risk-based Screening Criteria Development and Application

In the seventh step of the RBSC development process, a set of RBSCs protective of future residents and groundwater use at the Site were developed. The RBSCs consist of two sets for soil: one based on the combined RBSCs for soil exposures by future residents (i.e., ingestion, dermal, and dust inhalation, and indoor vapor inhalation), and one based on protection of a future use of groundwater as a drinking water source. The RBSCs for groundwater also consist of two sets: one based on groundwater use for potable purposes (consumption, dermal contact, and vapor inhalation during bathing or showering) and one based on migration of vapors from groundwater to indoor air. Those RBSCs based on a combination of exposure pathways were determined using the following equation:

$$\text{Combined RBSC}_{(\text{soil or water})} = \frac{1}{\sum\left(\frac{1}{RBSC_i}\right)}$$

To be consistent with the approach that the USEPA Region 9 (2004b) uses to express high remediation goals, any RBSCs greater than 100,000 mg/kg are expressed as that limit (i.e., > 100, 000 mg/kg). In cases where a RBSC for one pathway exceeds 100,000 mg/kg and that for another pathway does not, it will be assumed that the overall RBSC is comparable to the lower concentration. The RBSCs calculated for soil and groundwater are presented in Tables B-1.8 and B-1.10.

3.6.1 RBSC Application

The risk screening procedure is proposed to consist primarily of a comparison of a chemical-specific RBSC with a measured chemical concentration on a sample-by-sample basis. As part of this process, when multiple chemicals are detected in one sample, it is proposed to follow the same procedure recommended by USEPA (2004b) for assessing relative levels of human health risk. In this case, the ratios of measured chemical concentrations and RBSCs for carcinogenic or non-carcinogenic endpoints will be summed. This procedure will essentially result in the target risk for each carcinogen in a sample being a fraction of 1×10^{-5} (approaching 1×10^{-6} as suggested by OEHHA [2005]) and the target hazard index for each non-carcinogen being less than 1. For those samples in which only one or two carcinogens compounds are evaluated, the RBSCs may be reduced by a factor of 3 to account for the limited dataset. As appropriate, the ratios for the non-carcinogens will also be summed for chemical by toxic effect, for example as per the effects shown in Table B-1.11.

Several other factors will be considered as part of the use of the RBSCs, including (1) naturally occurring metal concentrations in soil, (2) ambient dioxin concentrations, (3) sample depth, and (4) groundwater discharge. The approaches proposed for incorporating each of these factors into the screening process are described below.

As appropriate, the results of the use of RBSCs for this Site will also be examined in terms of the uncertainties assumed in identifying the COPCs, quantifying exposures, estimating dose-response variables, and characterizing risks.

3.6.1.1 Naturally Occurring Metal Concentrations in Soil

Metals occur naturally in soils. USEPA (1989a) and DTSC (1999) guidance indicates that risk evaluations for metals are only necessary when the levels exceed naturally occurring background concentrations. Based on this determination and prior to developing site-specific background data, the RBSCs for metals in soils will only be applied when the measured concentrations exceed background metal concentrations observed in California soils. A separate report will describe the Site-specific approach for determining whether metals may exceed background and that will address DTSC (1997) and USEPA (2002b) guidance, which recommends the use of statistical testing for comparing site and background metal concentrations.

The initial evaluation of metals detected in soils will be a comparison with naturally occurring metal concentrations. For this Site, prior to a site-specific determination of background conditions, it is proposed to define background using metal concentrations measured in soil samples collected by Bradford et al. (1996) from 50 sampling locations across California (see Table B-1.9). Generally, statistical analyses are based on a comparison of means or medians (USEPA 2002b), including an evaluation of the variability around the mean, of two sample populations. At this Site, however, it is proposed to initially evaluate measured metal concentrations on a sample-by-sample basis. Thus, to account for variability in the background dataset, it is proposed to screen metal concentrations by comparison to the upper quartile (75th percentile) determined for metal concentrations in the California (Bradford et al. 1996) background metals dataset (see Table 8). Metal concentrations less than the upper quartile concentrations would not be compared to RBSCs.

Nevertheless, since there is high variability in the concentrations of certain metals measured in background (see Table B-1.9), it should be recognized that for each comparison there is approximately a twenty-five percent chance that a measured metal concentration may be within background, but exceed the upper quartile concentration (U.S. Navy 1999). Thus, a metal concentration exceeding the specified quartile will not be automatically considered as elevated above background levels. Rather, a second level of evaluation will be used in conjunction with RBSCs for the specified metal, prior to developing site-specific background data. This evaluation will consist of comparison of the specified metal with the maximum concentration observed in background and its RBSC. In this evaluation, metal concentrations exceeding the maximum background concentrations (Bradford et al. 1996) will be compared to their calculated RBSCs. Those metal concentrations exceeding the upper quartile but not the maximum background will be identified as requiring further evaluation, such as statistical analyses or use of a local background dataset for evaluation purposes.

3.6.1.2 Ambient Dioxin Concentrations

Ambient concentrations of dioxins and furans and the potential sources of these chemicals have been described in a report developed for this Site (Exponent 2004). Thus, dioxin concentrations (reported as tetrachlorodibenzo-dioxin [TCDD]-equivalents) detected in soils at this Site will be compared to ambient concentrations in soils. Only those concentrations exceeding ambient concentrations will be compared to the RBSC calculated for TCDD-equivalents.

3.6.1.3 Sample Depth

Soil contact by future on-site receptors is likely to be with surface or shallow soils (e.g., the top two to five feet, respectively). However, soils currently at the surface may or may not remain at the surface after completion of any interim remedial measures. Thus, to be protective, all chemical measurements in unsaturated soils will be compared to RBSCs. Additional considerations may need to be addressed, however, if chemical concentrations exceed RBSCs at depths greater than human or ecological receptors typically contact (10 or 5 feet below ground surface, respectively).

3.6.1.4 Groundwater Discharge

For ecological receptors, screening of chemicals in groundwater will be conducted only if the groundwater discharges directly to surface water.

4.0 ECOLOGICAL RISK-BASED SCREENING CRITERIA

The overall approach that is proposed for developing and applying ecological RBSCs for soil is based on the methodology developed by the U.S. Navy and USEPA, Region 9 Biological Technical Assistance Group (BTAG). This methodology consists of the application of low and high toxicity reference values to determine the level of ecological effects that may occur as a result of potential chemical exposures. As indicated in Section 2, ecological RBSCs will be developed for all detected compounds in soil. TPH mixtures will be evaluated using the presence of indicator compounds as recommended by USEPA (1989a,b) and Cal EPA (DTSC 1999) guidance.

4.1 Identification of Ecological Receptors and Indicator Species

Given the number of species and the complexity of biological communities, each species present at or near the Site will not be individually assessed. Rather, indicator species that are representative of those likely to be found at the Site were used to develop screening criteria.

A key strategy to focus and simplify the RBSC estimation process is to organize receptors of concern into guilds of ecologically and taxonomically related organisms and then select a representative species for each guild (DTSC 1996a). RBSCs were then calculated for the representative species. Representative species were selected to maximize estimates of exposure to ensure a conservative assessment of risk. Representative plant and animals were selected based on:

- Representativeness of biological receptors of concern and a high potential for exposure;
- Small body size and small home and/or foraging ranges; and
- Characteristics facilitating estimation and/or verification of COPC exposure.

Representative taxa were identified for this Site using the botanical survey and jurisdictional wetlands delineation conducted at the Site and surrounding area (TRC 2003). The survey also included a California Natural Diversity Database (CNDDB) search for special status species in the region. The following receptor taxa were selected to use in developing ecological RBSCs:

- ***Plants***. Toxicity data are only available for plants in general and few species-specific toxicity values are available for plant species likely to be present on the site.

- ***Herbivorous small mammals***. For this assessment, the deer mouse was used for estimation of exposure factors and toxicity, and was assumed to consume a diet consisting exclusively of plant tissue.

- ***Insectivorous small mammals***. For this assessment, the deer mouse was used for estimation of exposure factors and toxicity, and was assumed to consume a diet consisting exclusively of soil invertebrates.

- ***Aquatic organisms and sediment-associated organisms.*** For this assessment, these biological receptors will be those assumed to occur in freshwater, on-site ponds.

Because toxicity data are limited for birds, and because ecological risk assessments at other sites have indicated that risks to birds and small mammals are similar, separate RBSCs were not developed for birds. Also, since carnivorous animals (birds and mammals) typically have large foraging areas and RBSCs will generally be applied on a sample-by-sample basis, calculation of RBSCs will apply more fittingly to the exposures potentially experienced by ecological receptors with small ranges. Based on these determinations, RBSCs were not developed for carnivores.

4.2 Identification of Exposure Pathways of Ecological Concern

Exposure pathways include migration pathways (i.e., fate and transport of chemicals) and exposure routes. Exposure routes are mechanisms through which plants and animals uptake COPCs from environmental media of concern. Exposure routes of concern that were considered include:

- Root uptake of COPCs in soils (< 5 feet below ground surface [bgs]) by plants;

- Ingestion of COPCs in soils and food by terrestrial animals; and

- Inhalation of volatile COPCs in the confined air spaces of burrows by burrowing animals.

- Exposure of aquatic receptors to fresh surface waters and sediments.

Inhalation of volatile COPCs in subsurface soils was evaluated only for burrowing wildlife because these animals may spend a significant portion of their life in the confined air spaces of their burrows and, thus, may be exposed to volatile COPCs in subsurface soils. Volatile COPC concentrations in burrows was estimated using equilibrium partitioning between adsorbed and soil gas phases. RBSCs for VOCs in soils were developed separately for the inhalation and ingestion exposure routes.

Dermal absorption of metals and organic compounds is considered to be an insignificant exposure route and was not be evaluated because:

- Dense undercoats or down effectively prevent COPCs from reaching the skin of wildlife species and significantly reduce the total surface area of exposed skin (Peterle 1991; U.S. Army Corps of Engineers [USACE] 1996).

- Results of exposure studies indicate that exposures due to dermal absorption are insignificant compared to ingestion for terrestrial wildlife, including burrowers (Peterle 1991).

For ecological receptors, screening of chemicals in groundwater will be conducted only if the groundwater discharges directly to surface water.

Screening criteria for exposures of marine organisms to fresh surface waters discharging from the Log Pond or from groundwater were not developed, at this time. If necessary, these types of RBSCs will be addressed in the future.

4.3 Calculation of Exposures

The magnitude of environmental exposure of each COPC to each representative species can be calculated using pathway - specific exposure equations of the general form (DTSC 1996a,b; USEPA 1993):

$$Dose = \frac{C * CR * FC * AF}{BW}$$

where:

C = concentration of a COPC in media that is likely to be contacted by receptors of concern.
CR = contact rates (intake rates), which include wildlife exposure factors, such as ingestion and drinking rates.
FC = fraction of media contacted, a measure of the portion of the medium contacted and includes wildlife exposure factors, such as the site presence index and diet portions.
AF = assimilation fraction, the amount of the COPC absorbed through the root, gastrointestinal tract, lungs or skin (100 percent assimilation assumed).
BW = body weight of the animal

This general equation can be modified to produce equations that estimate COPC exposures for any exposure route. As appropriate, this equation will be re-arranged to calculate for chemical concentration in soil, i.e. the term “C”.

To facilitate comparisons with available toxicity data, estimates of exposure are reported in the following units:

- Root uptake by plants (mg_{COPC}/kg_{soil})
- Exposure to soil invertebrates (mg_{COPC}/kg_{soil})

- Ingestion by terrestrial wildlife ($mg_{COPC}/kg_{body\ wt}/day$)
- Inhalation by burrowing wildlife (mg_{COPC}/m^3)
- Exposure to aquatic receptors (mg_{COPC}/L)
- Exposure to sediment-associated invertebrates (mg_{COPC}/kg)

Estimates of exposure for root uptake; exposures to soil invertebrates, aquatic receptors, and sediment-associated invertebrates; and inhalation by burrowing wildlife are in units of concentration and do not require exposure equations.

Bioaccumulation by Plants*.* To evaluate COPC exposures to herbivores due to the ingestion of plants, COPC concentrations in soils were back calculated from acceptable levels in plants using chemical-specific soil-to-plant bioconcentration factors (BCFs). To be consistent with the human health RBSC development process, quantitative relationships between soil concentrations and plant tissue concentrations (i.e., BCFs) were obtained from the literature using the following priority: (1) Baes et al. (1984), (2) Bechtel Jacobs 1998, and (3) Travis and Arms 1988.

Bioaccumulation by Soil Invertebrates*.* To evaluate COPC exposures to insectivores due to the ingestion of soil invertebrates, COPC concentrations in soil were back calculated from acceptable invertebrate tissue concentrations using chemical specific soil-to-soil invertebrate BCFs. A review of the literature on soil invertebrate accumulation of metals indicates that, in general, only a few chemicals have been studied (Sample et al. 1996). Thus, when available, the soil-to-earthworm BCFs provided in Sample et al. 1996 were used to back-calculate soil concentrations from acceptable levels in soil invertebrates.

4.4 Exposure Parameters

The USEPA's (1993) *Wildlife Exposure Factors Handbook* and the California Department of Fish and Game's *California's Wildlife* (Airola 1988; Mayer and Laudenslayer 1988; Zeiner et al. 1988, 1990a,b) were used as sources of wildlife exposure factors. The primary literature was also reviewed during compilation of the wildlife exposure factors. Where species-specific data are lacking, allometric equations provided in USEPA's (1993) *Wildlife Exposure Factors Handbook* were used to estimate ingestion and drinking rates.

Wildlife exposure factors and their sources for identified plant and wildlife indicator species are provided in Attachment B-3.

For the purpose of developing ecological RBSCs, certain of the exposure factors were set to default values. Specific assumptions that were incorporated into the exposure assessment include:

- The Site Presence Index (SPI) was set to 1. This assumes that the receptor spends its entire lifespan on the Site.

- Burrowing mammals are assumed to spend 100% of their time in burrows and are continuously exposed to VOCs in burrow air.

4.5 Ecological Effects Assessment

4.5.1 Terrestrial Receptors

The purpose of the ecological effects assessment is to identify and quantify adverse effects elicited by released chemicals and, where possible, to evaluate cause-and-effect relationships (USEPA 1992b). Baseline ecological risk assessments rely on toxicity data available in the literature or compiled databases. Generally, the results of the ecological effects assessment are expressed as reference toxicity values (TRVs), which are then compared to the results of the exposure assessment to estimate the potential for adverse ecological effects. Exposures greater than TRVs are considered to pose a potential for adverse impacts. Ideally, TRVs are concentrations or doses at which effects begin to occur and below which no effects are observed. However, there is variation between toxicological studies on the same chemical. In addition, there is disagreement as to which toxicological endpoint or response is appropriate. Therefore, one set of TRVs may not adequately protect ecological receptors.

The ecological effects assessment follows the approach outlined in the Navy/BTAG document (U.S. Navy 1998). This approach utilizes two sets of TRVs, referred to as the TRV-Low and TRV-High, for each COPC. For the ingestion exposure pathway of mammals and birds, TRV-Lows and TRV-Highs are utilized to more accurately evaluate the range of potential impacts to wildlife receptors. TRVs for these receptors were obtained or derived primarily from regulatory-approved databases or compilation documents, including EFA West (1998); Tetra Tech (2002); Sample et al. (1996); IRIS (USEPA 2005); Ecotox (USEPA 2004c); Rocketdyne (2003); and U.S. Air Force (2004a).

All TRV-Lows used in the development of RBSCs are based on concentrations or doses that are not expected to produce adverse ecological effects. Media concentrations or doses at or below this level would not be expected to harm an individual or population of organisms. These values are based on a chronic no observable adverse effect level (NOAEL). In other words, this would be the highest dose evaluated that did not result in a biological response to individuals. The TRV-Lows used in the development of RBSCs, including both the Navy/BTAG (U.S. Navy 1998) and non-Navy/BTAG values, each represent the lowest credible chronic NOAEL.

The TRV-Highs used in the development of RBSCs fall into two distinct groups. First, for all of the non-Navy/BTAG TRV-Highs, the derived value is based on a chronic lowest observable adverse effect level, or LOAEL. In other words, it is the lowest dose tested that resulted in a biological response to individuals. Second, all of the Navy/BTAG TRV-Highs represent a level at which some adverse effects may occur and lie approximately in the middle of the range of possible adverse effects (U.S. Navy 1998). Thus the Navy/BTAG TRV-High is a value at which different adverse effects have been demonstrated and are, therefore, not necessarily based on LOAELs. In development of RBSCs, no distinction was made between the two different approaches to developing TRV-Highs. TRVs used in the calculations are presented in Appendix E.

Identified toxicity values based on test species, were scaled using the approach defined by Sample and Arenal (1999), as currently supported by the DSTC. There is a body of literature and theory that suggests that species sensitivities to contaminants are related to the metabolic rate of the organism, or its body weight. Metabolic rate is inversely proportional to body weight. Therefore, relative body weights can be used to scale RfDs between the test and receptor species. In general, the relationship takes the form:

$$RfD_{Receptor} = RfD_{TestSpp} \times \left(\frac{BW_{TestSpp}}{BW_{Receptor}} \right)^{b}$$

The exponent "b" may take on a variety of values, based on the assumptions and data used to derive it. Several values are typically used in risk assessment. Sample and Arenal (1999) reviewed a large quantity of toxicological effects literature for birds and mammals for a wide range of toxicants, and developed taxon and chemical-specific scaling factors. They also proposed a taxon-specific default scaling factor when no chemical-specific factor could be developed.

4.5.2 Aquatic Receptors

Risk-based screening criteria, based on ambient water quality criteria, will be used to screen concentrations of chemicals detected in surface water. The criterion selected for use as the RBSC is the lower of (1) the USEPA (2004c) ambient water quality criteria, (2) criteria published in the California Toxics Rule (CTR) (USEPA 2000), or (3) objectives specified in the North Coast Regional Water Quality Control Board (NCRWQCB) Basin Plan (Basin Plan) (NCRWQCB 2001).

Concentrations of detected chemicals in freshwater sediments will be screened using RBSCs based on the Threshold Effects Level (TEL) derived from benthic community studies and toxicity tests, as summarized in Buchmann (1999). The TEL represents the concentration below which adverse effects are expected to occur rarely, and therefore is protective of sediment quality.

4.6 Ecological Risk Characterization and Development of RBSCs

Risk characterization integrates the results of the exposure and ecological effects characterizations to evaluate the likelihood of adverse ecological effects associated with exposure to COPCs (USEPA 1992b).

4.6.1 Development of RBSCs

The development of RBSCs was based on the HQ approach. An HQ is the ratio of the environmental exposure via a particular exposure route to the TRV:

$$Hazard\ Quotient\ (HQ) = \frac{Exposure}{TRV}$$

An environmental medium concentration that results in a HQ = 1 represents that point above which adverse effects may be noted. RBSCs were based on the back calculation of the environmental medium concentration that results in an HQ = 1. For each indicator species, RBSCs were calculated using both the TRV-Low and TRV-High, where applicable. The most protective ecological RBSCs are shown in Table B-1.8 (with supporting values provided in Attachment B-3).

4.6.2 Application of Ecological Risk-based Screening Criteria

As discussed in Section 3.6.1, prior to developing site-specific background data, metals in soils will be first compared to the upper quartile (75th percentile) determined for metal concentrations in the California (Bradford et al. 1996) background metals dataset (Figure B-2). Metal concentrations less than the upper quartile concentrations would not be compared to RBSCs because they are considered to be naturally occuring levels. Metal concentrations exceeding the maximum background concentrations (Bradford et al. 1996) will be compared to their calculated RBSCs (see Table B-1.9). Those metal concentrations exceeding the upper quartile but not the maximum background will be identified as requiring further evaluation, such as statistical analyses or use of a local background dataset for evaluation purposes, although they will also be compared to their RBSCs.

All remaining metals and organic compounds will be compared to the ecological RBSCs (Figure B-3). The screening approach proposed for use with the ecological RBSCs employs the Navy-BTAG methodology (U.S. Navy 1998). Measured concentrations are first compared to the low RSBC. Because of the protective nature of the TRV, concentrations that are below this value are unlikely to represent any potential for ecological effects. Those concentrations exceeding the low RBSC would then be compared to the high RBSC. Because the high RBSC is based on a LOAEL-equivalent exposure, values exceeding the high RBSC are considered likely to result in ecological effects. These sampling locations are candidates for further characterization. Sample concentrations falling between the low and the high RBSCs indicate that a site-specific ecological risk assessment be performed to fully evaluate the potential for ecological effects.

Screening of Surface Water and Sediments
Concentrations of detected chemicals in surface water will be screened using RBSCs based on ambient water quality criteria (Section 4.5). Concentrations of detected chemicals in freshwater sediments will be screened using RBSCs based on the Threshold Effects Level (TEL). Sample locations exceeding these criteria will be identified as candidates for further evaluation.

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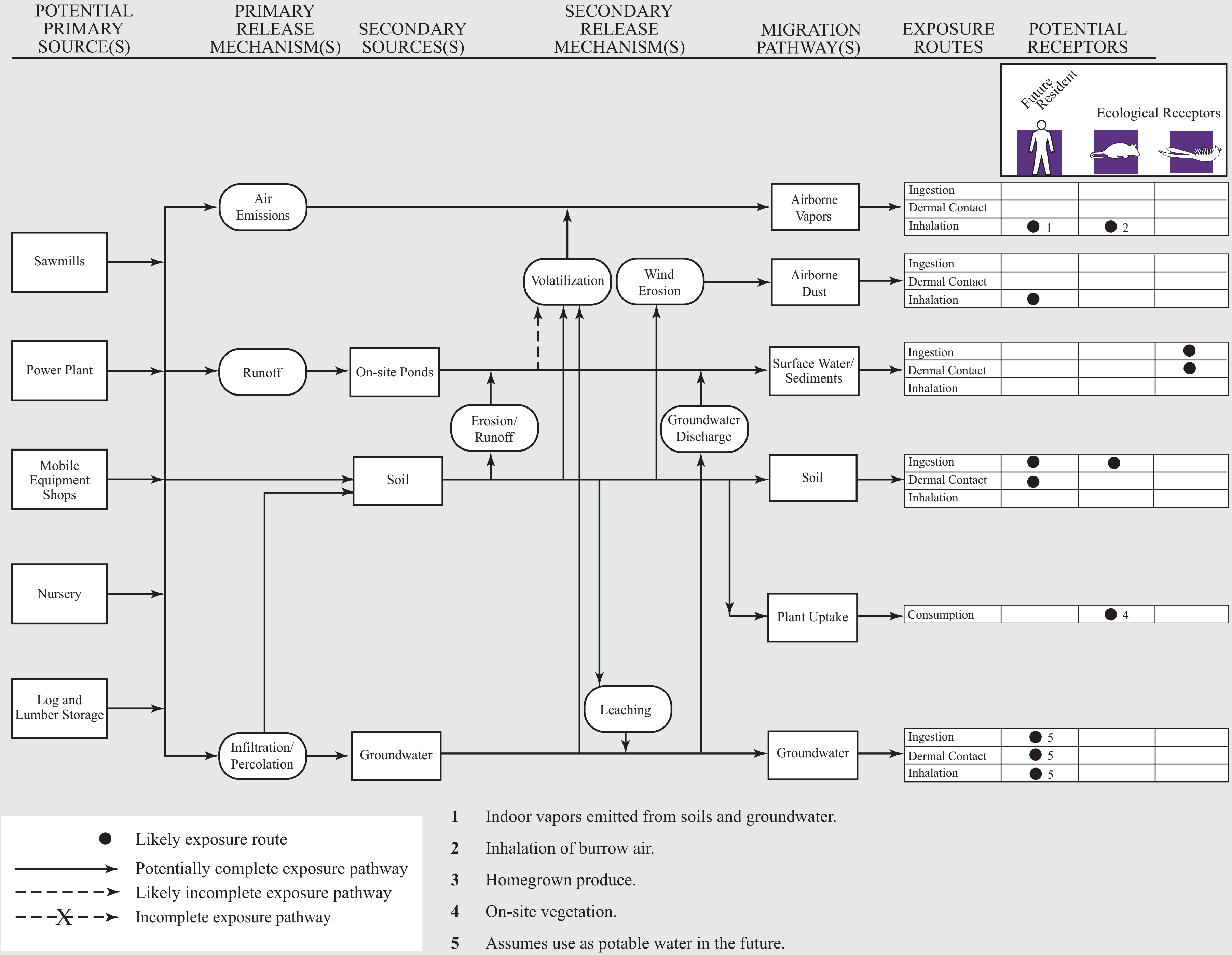

1 Indoor vapors emitted from soils and groundwater.

2 Inhalation of burrow air.

3 Homegrown produce.

4 On-site vegetation.

5 Assumes use as potable water in the future.

Figure B-1
Conceptual Site Model for Human and Ecological Receptors for Screening Evaluation

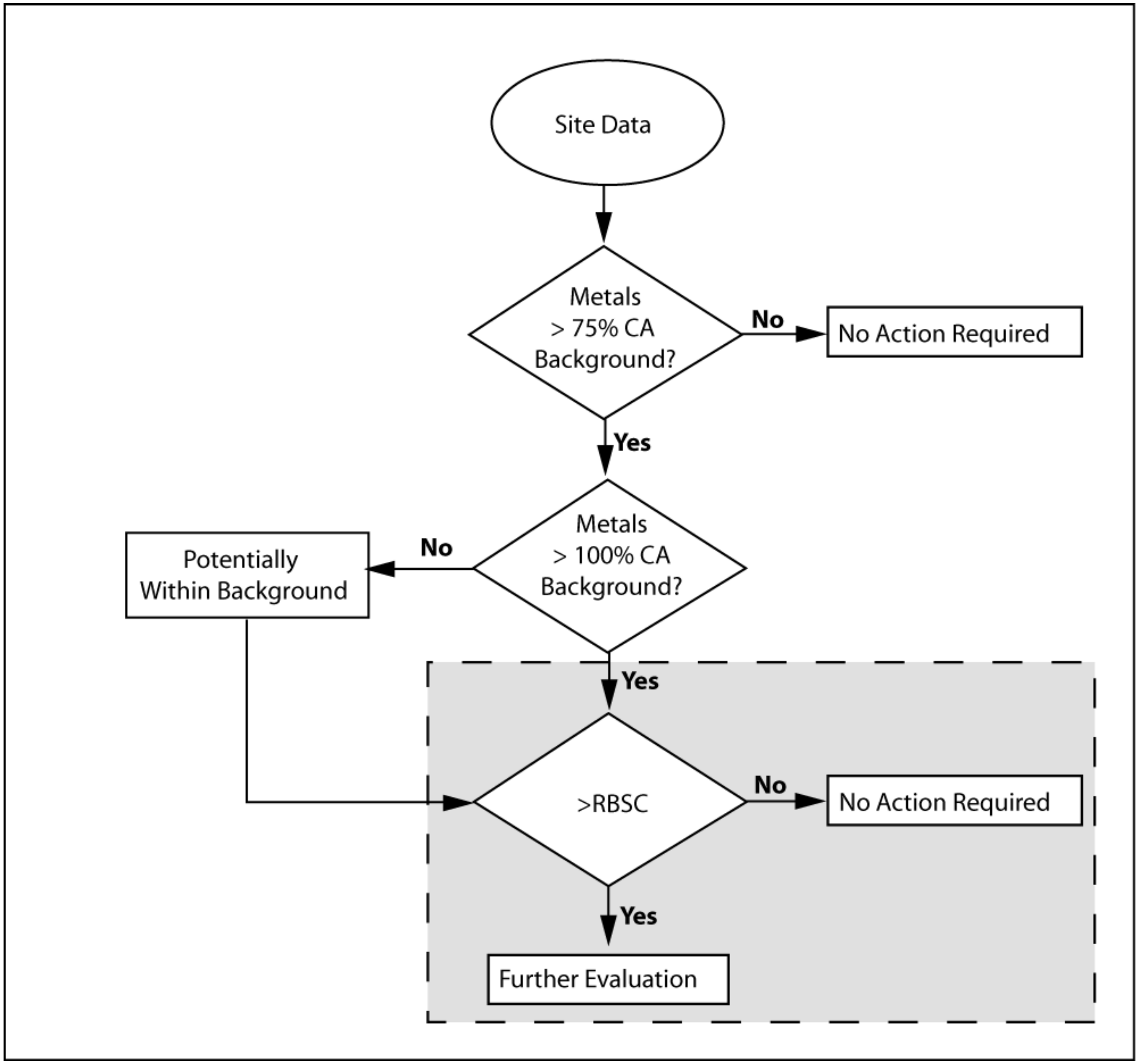

Figure B-2. Overall RBSC Screening Approach. Shaded area is described in further detail in Figure 3.

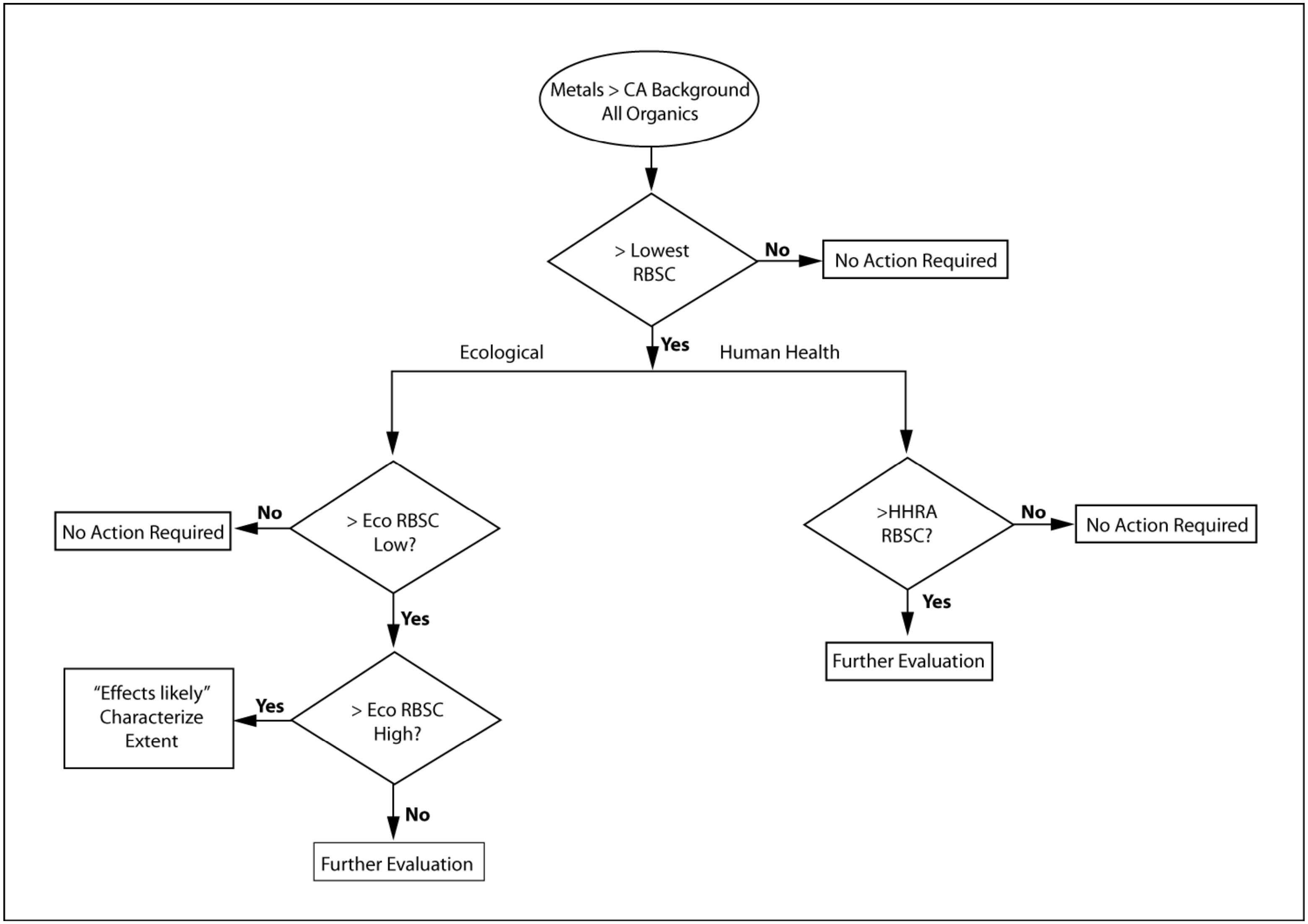

Figure B-3. Detailed Approach to Conducting Comparisons to RBSCs.

Table B-1.1
Preliminary List of Chemicals of Potential Concern
Georgia Pacific Corporation
Fort Bragg, California

	Environmental Medium		
		Groundwater	
Chemical	**Soil**	**4th Quarter 2004**	**3rd Quarter 2005**
METALS			
Antimony	X		
Arsenic	X	X	
Barium	X	X	
Beryllium	X	X	
Cadmium	X		
Chromium	X		
Cobalt	X		
Copper	X		
Lead	X		
Mercury	X		
Molybdenum	X		
Nickel	X		
Selenium	X	X	
Silver	X		
Thallium	X		
Vanadium	X		
Zinc	X	X	
ORGANICS			
Volatile Organic Compounds (VOCs)			
Acetone	X		X
Benzene		X	
2-Butanone	X		
n-Butylbenzene	X		
sec-Butylbenzene	X		
Carbon disulfide			X
Chloroform			X
1,1-Dichloroethane	X	X	
1,1-Dichloroethene			X
cis-1,2-Dichloroethene	X	X	
trans-1,2-Dichloroethene	X		
Ethylbenzene	X		
Freon 113			X
Isopropanol (Isopropyl alcohol)			X
Isopropylbenzene	X		
para-Isopropyl Toluene	X		
Methylene chloride	X		
MTBE	X	X	
Naphthalene	X	X	
Propylbenzene		X	
Tetrachloroethene (PCE)		X	
Toluene	X		
1,1,1-Trichloroethane		X	
Trichloroethene (TCE)		X	
1,2,4-Trimethylbenzene	X		
1,3,5-Trimethylbenzene	X		

Table B-1.1
Preliminary List of Chemicals of Potential Concern
Georgia Pacific Corporation
Fort Bragg, California

	Environmental Medium		
		Groundwater	
Chemical	**Soil**	**4th Quarter 2004**	**3rd Quarter 2005**
m,p-Xylenes	X		
o-Xylene	X		
Semi-Volatile Organic Compounds (SVOCs)			
Acenaphthene	X		
Benzo(a)-anthracene	X		
Benzo(b)-fluoranthene	X		
Benzo(k)-fluoranthene	X		
Benzoic Acid			X
Chrysene	X		
Flouranthene			X
Fluorene	X		
2-Methylnaphthalene	X		
Naphthalene	X		
N-Nitrosodiphenylamine	X		
Phenanthrene	X		
Phenol			X
Pyrene	X		
Polychlorinated Biphenyls (PCBs)	X		
Tetrachlorodibenzo-dioxins and -fur	X		

Table B-1.2
Estimation of Risk-based Screening Criteria
Soil Contact and Inhalation Pathways
Residential Exposures to Carcinogens
Georgia Pacific Corporation
Fort Bragg, California

$$C_s = \frac{TR \times AT}{EF \times \left[\left(\left(\frac{ED_c \times IR_c}{BW_c} + \frac{ED_a \times IR_a}{BW_a} \right) \times \frac{SF_o}{10^6\, mg/kg} \right) + \left(\left(\frac{ED_c \times AF_c \times SA_c}{BW_c} + \frac{ED_a \times AF_a \times SA_a}{BW_a} \right) \times \frac{ABS \times SF_o}{10^6\, mg/kg} \right) + \left(\left(\frac{ED_c \times INR_c}{BW_c} + \frac{ED_a \times INR_a}{BW_a} \right) \times PEF \times SF_i \right) \right]}$$

Variable	Parameter	Value	Source/Rationale
C_s	Risk based concentration for soil	mg/kg	Units for soil
TR	Target Risk	10^{-5} (-)	USEPA 1989
BW_c	Child Body Weight	15 kg	USEPA 1991b, 2002a
BW_a	Adult Body Weight	70 kg	USEPA 1991b, 2002a
AT	Averaging Time	70 years x 365 days/year	Lifetime [USEPA 1989]
EF	Exposure Frequency	350 days/year	USEPA 1991b, 2002a
ED_c	Child Exposure Duration	6 years	USEPA 1991b, 2002a
ED_a	Adult Exposure Duration	24 years	USEPA 1991b, 2002a
IR_c	Child Soil Ingestion Rate	200 mg/day	USEPA 1991b, 2002a
IR_a	Adult Soil Ingestion Rate	100 mg/day	USEPA 1991b, 2002a
SF_o	Oral/dermal carcinogenic slope factor	chemical-specific	-
SF_i	Inhalation carcinogenic slope factor	chemical-specific	-
SA_c	Child Skin Surface Area	2,900 cm^2	DTSC 2000a
SA_a	Adult Skin Surface Area	5,700 cm^2	DTSC 2000a
AF_c	Child Soil Adherence Factor	0.2 mg/cm^2	DTSC 2000; USEPA 2004
AF_a	Adult Soil Adherence Factor	0.07 mg/cm^2	DTSC 2000; USEPA 2004
ABS	Absorption Fraction	chemical-specific	DTSC 1999
INR_c	Child Inhalation Rate	10 m^3/day	USEPA 1997a
INR_a	Adult Inhalation Rate	20 m^3/day	USEPA 1991b, 2002a
PEF	Particulate Emissions Factor	2.45E-10 kg/m^3	USEPA 1996

Table B-1.3
Estimation of Risk-based Screening Criteria
Soil Contact and Inhalation Pathways
Residential Exposures to Non-Carcinogens
Georgia Pacific Corporation
Fort Bragg, California

$$C_s = \frac{THQ \times BW \times AT}{EF \times ED \times \left[\left(\frac{IR}{RfD_o \times 10^6 mg/kg} \right) + \left(\frac{SA \times AF \times ABS}{RfD_o \times 10^6 mg/kg} \right) + \left(\frac{INR \times PEF}{RfD_i} \right) \right]}$$

Variable	Parameter	Value	Source/Rationale
C_s	Risk based concentration for soil	mg/kg	Units for soil
THQ	Target Hazard Quotient	1 (-)	USEPA 1989
BW	Body Weight		
	Resident, child	15 kg	USEPA 1991b, 2002a
AT	Averaging Time	ED x 365 days/year	USEPA 1989
EF	Exposure Frequency		
	Resident, child	350 days/year	USEPA 1991b, 2002a
ED	Exposure Duration		
	Resident, child	6 years	USEPA 1991b, 2002a
IR	Soil Ingestion Rate		
	Resident, child	200 mg/day	USEPA 1991b, 2002a
RfD_o	Oral/dermal reference dose	chemical-specific	-
RfD_i	Inhalation reference dose	chemical-specific	-
SA	Skin Surface Area		
	Resident, child	2,900 cm^2	DTSC 2000a
AF	Soil Adherence Factor		
	Resident, child	0.2 mg/cm^2	DTSC 2000a; USEPA 2004a
ABS	Absorption Fraction	chemical-specific	DTSC 1999
INR	Inhalation rate		
	Resident, child	10 m^3/day	USEPA 1997a, 2002a
PEF	Particulate Emissions Factor	2.45E-10 kg/m^3	USEPA 1996

Table B-1.4
Estimation of Risk-based Screening Criteria Exposure Parameters for
Groundwater Ingestion, Dermal Contact, and Vapor Inhalation
for Carcinogens
Resident
Georgia Pacific Corporation
Fort Bragg, California

$$C_w = \frac{TR \times AT \times 1{,}000\,\mu g/mg}{EF \times \left[\left(\left(\frac{ED_c \times IR_c}{BW_c} + \frac{ED_a \times IR_a}{BW_a}\right) \times SF_o\right) + \left(\left(\frac{ED_c \times ET \times SA_c}{BW_c} + \frac{ED_a \times ET \times SA_a}{BW_a}\right) \times \left(\frac{SF_o \times PC}{1{,}000\,cm^3/L}\right)\right) + \left(\left(\frac{ED_a \times ET \times INR_a}{BW_a}\right) \times \frac{SF_i}{VF \times 24hr/day}\right)\right]}$$

Variable	Parameter	Value		Source/Rationale
C_w	Risk based concentration for groundwater		ug/L	Units for water
TR	Target Risk	10^{-5}	(-)	USEPA 1989
BW_c	Child Body Weight	15	kg	USEPA 1991a, 1997a
BW_a	Adult Body Weight	70	kg	USEPA 1991a, 1997a
AT	Averaging Time	70 years x 365 days/year		Lifetime [US EPA 1989]
EF	Exposure Frequency	350	days/year	USEPA 1991a
ED_c	Child Exposure Duration	6	years	USEPA 1991a
ED_a	Adult Exposure Duration	24	years	USEPA 1991a
SF_o	Oral/dermal carcinogenic slope factor	chemical-specific		-
SF_i	Inhalation carcinogenic slope factor	chemical-specific		-
IR_c	Child Water Ingestion Rate	1	L/day	USEPA 1991a
IR_a	Adult Water Ingestion Rate	2	L/day	USEPA 1991a, 2002a
SA_c	Child Skin Surface Area (bathing)	6,600	cm^2	USEPA 2004a
SA_a	Adult Skin Surface Area (showering)	18,000	cm^2	USEPA 2004a
PC	Dermal permeability constant for water	-	cm/h	Chemical-specific
INR_a	Adult Inhalation Rate (showering)	20	m^3/day	USEPA 1991a
ET_a	Adult Exposure Time (showering)	0.25	hour/day	Based on a 15-minute shower [DTSC 1992]
Etc	Child Exposure Time (bathing)	0.25	hour/day	Based on a 15-minute bath [DTSC 1992]
VF	Volatilization Factor	chemical-specific	L/m^3	USEPA 1991a; only calculated for volatile chemicals

Table B-1.5
Estimation of Risk-based Screening Criteria Exposure Parameters
Groundwater Ingestion, Dermal, and Vapor Inhalation
for Non-Carcinogens
Resident
Georgia Pacific Corporation
Fort Bragg, California

$$C_w = \frac{THQ \times AT \times 1{,}000\ \mu g/mg}{EF \times \left[\frac{ED \times IR}{BW \times RfD_o} + \frac{ED \times SA \times PC \times ET}{BW \times RfD_o \times 1000\ cm^3/L} + \frac{ET \times ED \times INR}{BW \times RfD_i \times VF \times 24\ hr/day} \right]}$$

Variable	Parameter	Value		Source/Rationale
C_w	Risk based remedial goal for groundwater		ug/L	Units for water
THQ	Target Hazard Quotient	1	(-)	USEPA 1989
C_w	Risk based concentration for groundwater		ug/L	Units for water
THQ	Target Hazard Quotient	1	(-)	USEPA 1989
BW_a	Adult Body Weight	70	kg	USEPA 1991a, 1997a
AT	Averaging Time	ED x 365	days/year	USEPA 1989
EF	Exposure Frequency	350	days/year	USEPA 1991a
ED_a	Adult Exposure Duration	24	years	USEPA 1991a
RfDo	Oral/dermal noncarcinogenic reference dos	chemical-specific		-
RfDi	Inhalation noncarcinogenic reference dose	chemical-specific		-
IR_a	Adult Water Ingestion Rate	2	L/day	USEPA 1991a
SA_a	Adult Skin Surface Area (showering)	18,000	cm^2	USEPA 2004a
PC	Dermal permeability constant for water	-	cm/h	Chemical-specific
INR_a	Adult Inhalation Rate	20	m^3/day	USEPA 1991a
ET	Exposure Time	0.25	hour/day	Based on a 15-minute shower [DTSC 1992]
VF	Volatilization Factor	chemical-specific	L/m^3	USEPA 1991a; only calculated for volatile chemicals

Table B-1.6
Estimation of Acceptable Indoor Vapor Levels
Vapor Inhalation
Resident
Georgia Pacific Corporation
Fort Bragg, California

Carcinogens:

$$C_a = \frac{TR \times AT}{EF \times \left(\frac{ED_c \times INR_c}{BW_c} + \frac{ED_a \times INR_a}{BW_a} \right) \times SF_i}$$

Non-carcinogens:

$$C_a = \frac{THQ \times BW_c \times AT \times RfD_i}{EF \times ED_c \times INR_c}$$

Variable	Parameter		Value	Source/Rationale
C_a	Risk-based concentration for air		mg/m^3	Units for air
TR	Target Risk		10^{-5} (-)	USEPA 1989
AT	Averaging Time			
		Carcinogens	70 years x 365 days/year	Lifetime (USEPA 1989)
		Noncarcinogens	ED x 365 days/year	USEPA 1989
EF	Exposure Frequency		350 days/year	USEPA 1991a, 2002a
ED	Exposure Duration		30 years	
	ED_c	Child Exposure Duration	6 years	USEPA 1991a
	ED_a	Adult Exposure Duration	24 years	USEPA 1991a
INR	Inhalation rate			
	INR_c	Resident, child	10 m^3/day	USEPA 1997a
	INR_a	Resident, adult	20 m^3/day	USEPA 1991a, 2002a
BW	Body Weight			
	BW_c	Resident, child	15 kg	USEPA 1991a, 2002a
	BW_a	Resident, adult	70 kg	USEPA 1991a, 2002a
Sf_o	Inhalation slope factor		chemical-specific	-
RfD_o	Inhalation reference dose		chemical-specific	-

Table B-1.7
Exposure Factors for Indicator Species
Georgia Pacific Corporation
Fort Bragg, California

Guild		Body Weight [FW]	Food Ingestion Rate [DW]	Drinking Rate			Diet Proportions				Soil Depth	Home Range or Territory	
Common Name	Scientific Name	(g)	(g/d)	(mL/d)	SPI	Food Item	Soil	Plant	Invert.	Mammal	(ft bgs)	(ha)	Source
Plants													
Grasses and forbs		—	—	—	1	—	—	—	—	—	0–1	0	
Shrubs		—	—	—	1	—	—	—	—	—	0–2	0	
Trees		—	—	—	1	—	—	—	—	—	0–5	0	
Mammals													
Herbivorous mammals													
Deer mouse	*Peromyscus maniculatus*	19.3	3.77	3.7	1	grasses	2.0%	100.0%	0%	0%	0–1	0.46	1, 2, 3, 4
Insectivorous mammals													
Deer mouse	*Peromyscus maniculatus*	19.3	3.77	3.66	1	soil invertebrates	2.0%	0%	100.0%	0%	0–1	0.46	1, 2, 3, 4

Definitions:

AOC	-	area of concern
ft bgs	-	feet below ground surface
FW	-	fresh weight
ft	-	feet
g	-	grams
SPI	-	site presence index
g/d	-	grams per day
ha	-	hectares
mL/d	-	milliliters per day
U.S. EPA	-	U.S. Environmental Protection Agency

Sources:

1	-	Body weights were taken from average of adult mean body weights in U.S. EPA (1993).
2	-	Food ingestion and water intake rates taken from U.S. EPA (1993)
3		Percent soil in diet were obtained from Beyer *et al.* (1994). Values were derived from species with similar feeding biology.
4	-	Territory or home range from U.S. EPA (1993).

Table B-1.8
Risk-based Human Health and Ecological Screening Criteria for Soil
Georgia-Pacific Wood Products Facility
Fort Bragg, California

	Human Health and Groundwater Protective RBSCs for Soil				Ecological RBSCs for Soil	
	Soil Contact and Indoor Vapor		Migration to Groundwater			
Chemical	**Carcinogenic**	**Non-Carcinogenic**	**Carcinogenic**	**Non-Carcinogenic**	**Low**	**High**
METALS						
Antimony	-	30	-	-	0.17	3
Arsenic	0.6	22	-	-	10	554
Barium	-	15,202	-	-	339	1,245
Beryllium	32,658	152	-	-	10	309
Cadmium	-	78	-	-	0.02	2
Chromium	-	>100,000	-	-	5	43,836
Cobalt	27,992	1,459	-	-	38	858
Copper	-	3,040	-	-	33	7,813
Lead[1]	-	255	-	-	12	7,515
Mercury	-	23	-	-	0.3	24
Molybdenum	-	380	-	-	1.4	14
Nickel	>100,000	1,520	-	-	0.8	185
Selenium	-	380	-	-	0.2	13
Silver	-	380	-	-	0.9	5
Thallium	-	6	-	-	1	9
Vanadium	-	532	-	-	20	203
Zinc	-	22,803	-	-	0.2	1,925
ORGANICS						
Volatile Organic Compounds (VOCs)						
Acetone	-	93	-	3	0.08	0.4
Benzene	0.002	0.04	0.003	0.1	0.002	0.4
2-Butanone	-	147	-	4	44	78
n-Butylbenzene	-	2	-	10	0.004	0.02
sec-Butylbenzene	-	640	-	9	0.005	0.02
Carbon disulfide	-	0.2	-	3	-	-
Chloroform	0.01	0.1	0.01	0.1	-	-
1,1-Dichloroethane	0.02	0.5	0.04	1	-	-
1,1-Dichloroethene	-	0.1	-	1	-	-
cis-1,2-Dichloroethene	-	0.05	-	0.1	0.005	286
trans-1,2-Dichloroethene	-	0.01	-	0.3	0.003	286
Ethylbenzene	-	7	-	19	0.009	0.04
Freon 113	-	-	-	186	-	-
Isopropanol	-	-	-	-	-	-
Isopropylbenzene	-	0.1	-	39	0.009	0.05
para-Isopropyl Toluene	-	33	-	145	1.8	448
Methylene chloride	0.05	3	0.02	1	0.002	4
Methyl-tert-butyl ether (MTBE	0.5	9	0.1	0.1	0.31	-
Propylbenzene	-	1	-	6	-	-
Tetrachloroethene (PCE)	0.01	0.04	0.01	0.4	0.02	0.09
Toluene	-	1	-	6	0.001	0.08
1,1,1-Trichloroethane	-	2	-	16	0.1	489
Trichloroethene (TCE)	0.004	0.01	0.1	0.1	0.02	0.4
1,2,4-Trimethylbenzene	-	0.2	-	1	1	3
1,3,5-Trimethylbenzene	-	0.2	-	1	0.4	3
m,p-Xylenes	-	1	-	4	0.09	2
o-Xylene	-	1	-	3	0.09	3
Semi-Volatile Organic Compounds (SVOCs)						
Acenaphthene	-	1,453	-	122	12	24
Benzo(a)anthracene	4	1,090	-	-	0.2	5
Benzo(b)fluoranthene	4	1,090	-	-	0.1	2
Benzo(k)fluoranthene	4	1,090	-	-	0.1	2
Benzoic Acid	-	242,522	-	-	-	-
Chrysene	36	1,090	-	-	0.11	3
Fluoranthene	-	2,272	-	-	-	-
Fluorene	-	1,753	-	-	6	13
2-Methylnaphthalene	-	4	-	1	2	18
Naphthalene	1	2	0.1	1	0.2	18
N-Nitrosodiphenylamine	537	1,213	-	-	-	-
Phenanthrene	-	178	-	3	-	-
Phenol	-	18,189	-	-	4	7
Pyrene	-	1,635	-	-	4	7

Table B-1.8
Risk-based Human Health and Ecological Screening Criteria for Soil
Georgia-Pacific Wood Products Facility
Fort Bragg, California

	Human Health and Groundwater Protective RBSCs for Soil					Ecological RBSCs for Soil	
	Soil Contact and Indoor Vapor		Migration to Groundwater				
Chemical	**Carcinogenic**	**Non-Carcinogenic**	**Carcinogenic**	**Non-Carcinogenic**		**Low**	**High**
PCBs	1	4	-	-		0.6	1.4
TCDD	0.00004	-	-	-		0.000005	0.00004
Total Petroleum Hydrocarbons (TPH)							
TPH C6-C8	-	2	TPH C6-C8	29		-	-
TPH C8-C10	-	11	TPH C8-C10	32		-	-
TPH C10-C12	-	17	TPH C10-C12	33		-	-
TPH C12-C16	-	109	TPH C12-C16	68		-	-
TPH C16-C24	-	1,819	TPH C16-C24	493		-	-
TPH C24-C36	-	1,819	TPH C24-C36	-		-	-

Definitions:
mg/kg - milligrams per kilogram
PCBs - polychlorinated biphenyls
RBSC - risk-based screening criteria
TCDD - 2,3,7,8-tetrachlorodibenzo-dioxins and -furans

Notes:
All units are in mg/kg

Table B-1.9
Comparison of RBSCs and California Background Metal Concentrations in Soil
Georgia-Pacific Wood Products Facility
Fort Bragg, California

	California Background Soils[1]				Human Health RBSCs		Ecological RBSCs	
Metal	**Minimum**	**Median**	**Upper Quartile**	**Maximum**	**Carcinogenic**	**Non-Carcinogenic**	**Low**	**High**
Antimony	0.15	0.47	0.73	1.95	-	30	0.17	3
Arsenic	0.6	2.7	4.7	11	0.6	22	10	554
Barium	133	519.5	625	1400	-	15,202	339	1,245
Beryllium	0.25	1.265	1.53	2.7	32,658	152	10	309
Cadmium	0.05	0.275	0.44	1.7	-	78	0.02	2
Chromium	23	69	115	1579	-	114,014	5	43,836
Cobalt	2.7	11.6	18.3	46.9	27,992	1,459	38	858
Copper	9.1	21.6	36.6	96.4	-	3,040	33	7,813
Lead	12.4	20.6	26.7	97.1	-	255	12	7,515
Mercury	0.05	0.19	0.34	0.9	-	23	0.3	24
Molybdenum	0.1	0.85	1.4	9.6	-	380	1.4	14
Nickel	9	27	56	509	301,457	1,520	0.8	185
Selenium	0.015	0.015	0.05	0.43	-	380	0.2	13
Silver	0.1	0.37	0.53	8.3	-	380	0.9	5
Thallium	0.17	0.54	0.69	1.1	-	6	1	9
Vanadium	39	94	134	288	-	532	20	203
Zinc	88	153	170	236	-	22,803	0.2	1,925

Definitions:

RBSC - risk-based screening criteria

Notes:

All units in mg/kg

1 - Data presented in Bradford et al. (1996)

Table B-1.10
Risk-based Screening Criteria for Chemicals in Groundwater
Georgia-Pacific Wood Products Facility
Fort Bragg, California

Chemical	RBSCs for Potable Water Use		RBSCs for Groundwater Protective of Residential Exposures to Indoor Vapors	
	Carcinogenic	Non-carcinogenic	Carcinogenic	Non-carcinogenic
METALS				
Arsenic	0.07	11	-	-
Barium	-	729	-	-
Beryllium	-	73	-	-
Nickel	-	730	-	-
Selenium	-	182	-	-
Zinc	-	10,940	-	-
ORGANICS				
Volatile Organic Compounds (VOCs)				
Acetone	-	8,715	-	>100,000
Benzene	1.4	52	17	344
2-Butanone	-	10,345	-	-
n-Butylbenzene	-	299	-	-
sec-Butylbenzene	-	313	-	-
Carbon disulfide	-	1,227	-	1,176
Chloroform	7	75	114	503
1,1-Dichloroethane	25	943	332	6,158
1,1-Dichloroethene	-	404	-	434
cis-1,2-Dichloroethene	-	70	-	614
trans-1,2-Dichloroethene	-	136	-	-
Ethylbenzene	-	1,639	-	-
Freon 113	-	-	-	-
Isopropylbenzene	-	950	-	-
para-Isopropyl Toluene	-	957	-	-
Methylene chloride	24	1,678	-	-
Methyl-tert-butyl ether (MTBE	131	8,050	12,449	>100,000
Propylbenzene	-	330	-	1,461
Tetrachloroethene (PCE)	1	82	33	161
Toluene	-	1,015	-	-
1,1,1-Trichloroethane	-	3,920	-	9,065
Trichloroethene (TCE)	18	10	152	247
1,2,4-Trimethylbenzene	-	18	-	-
1,3,5-Trimethylbenzene	-	17	-	-
m,p-Xylenes	-	303	-	-
o-Xylene	-	259	-	-
Semi-Volatile Organic Compounds (SVOCs)				
Benzoic Acid	-	>100,000	-	-
Flouranthene	-	1,093	-	-
Naphthalene	2	10	250	598
Phenol	-	10,879	-	-
Total Petroleum Hydrocarbons (TPH)				
TPH C6-C8	-	932	-	706
TPH C8-C10	-	654	-	4,589
TPH C10-C12	-	439	-	7,392
TPH C12-C16	-	445	-	40,279
TPH C16-C24	-	1,029	-	-
TPH C24-C36	-	1,021	-	-

Definitions:

ug/L - micrograms per liter
RBSC - risk-based screening criteria

Notes:

All units are in ug/L

Table B-1.11
Example: Critical Effects and Toxic Endpoints
Ingestion Exposure Route
Georgia Pacific Corporation
Fort Bragg, California

	Critical effect/Toxic endpoint															
Chemical	Alimentary	Bone	Blood	CNS	Developmental	Endocrine	Eye	Heart/Cardiovascular	Immune	Kidney	Liver	Reproductive	Respiratory	Skin/hair/nails	Weight loss	Notes
METALS																
Antimony			I													
Arsenic								I						I		
Barium			I							I						
Beryllium	I															
Cadmium										I						
Chromium (as III)																1
Cobalt																1
Copper																1
Manganese				I												
Mercury (as mercuric chloride)									I							
Molybdenum										I						
Nickel															I	
Selenium														I		
Silver														I		
Thallium (as thallium chloride)			I													
Zinc			I													

Key:

I - USEPA IRIS critical effect

Notes:

1 - No effects given

APPENDIX B
ATTACHMENT B-2

CHEMICAL FATE AND TRANSPORT ANALYSIS

ATTACHMENT B-2

CHEMICAL FATE AND TRANSPORT ANALYSIS

The chemicals of potential concern identified at the Site can potentially migrate through various environmental media from the soils and groundwater. Potential migration pathways that were evaluated at the Site include volatilization from soil to indoor air, volatilization from groundwater to indoor air, volatilization from water used for potable purposes (i.e., showering), and chemical leaching from soil to groundwater. The model-predicted relationships were then used to generate risk-based screening criteria.

The definition of chemicals that were modeled is presented in Section 1. Migration of volatile organic compounds (VOCs) from soil to indoor air and groundwater to indoor air was conducted using the Johnson and Ettinger indoor air model [USEPA 2003], as modified according to DTSC (2005) guidance, and is presented in Section 2. The potential for chemicals in water to volatilize to shower vapors was estimated using a simulation model described by McKone (1987, 1991), and is presented in Section 3. Migration of VOCs from soils to groundwater was evaluated using equilibrium analysis and is presented in Section 4.

1. Chemical and Source Definition for Fate and Transport Modeling

Soil and groundwater sampling conducted at the Site was used to identify volatile chemicals. All detected volatile chemicals were evaluated in the fate and transport modeling. Emission modeling was performed for those organic chemicals that met both of the following criteria [USEPA 1996]:

- Molecular weight < 200 g/mol
- Henry's law constant ≥ 1 x 10^{-5} atm-m^3/mol

Total Petroleum Hydrocarbons (TPH) were also evaluated as if they represented individual compounds in the fate and transport modeling. Chemical properties were taken from the Total Petroleum Hydrocarbon Criteria Working Group Volume 3 [TPHCWG 1997]. Where chemical properties required by the fate and transport models were not available, chemical surrogates were defined and chemicals properties from the Johnson and Ettinger indoor air model [USEPA 2003] were used. Chemical properties are presented in Table B-2.1.

2. Indoor Air Predictions

The Johnson and Ettinger indoor air model [USEPA 2003] calculates the intrusion and subsequent accumulation of chemical vapors in buildings from subsurface soils and groundwater. The model incorporates both convective and diffusive mechanisms that drive vapor intrusion rates, and also account for subsurface soil and building properties. The Johnson and Ettinger indoor air model is recommended in the *Air/Superfund National Technical Guidance Study Series on Assessing Potential Indoor Air Impacts for Superfund Sites* [USEPA 1992]. The model is shown in detail in the Johnson and Ettinger model user's guide [USEPA 2003].

The Johnson and Ettinger infinite source model, as modified according to DTSC (2005) guidance, was used to model emissions to indoor air. Model input data include soil and building properties. Site-wide averages of soil physical properties are used in the modeling and are presented in Table B-2.2. Building properties are default data from guidance and are presented in Table B-2.3. Because the modeling was conducted to calculate risk-based screening criteria, a unitary source concentration (i.e., starting concentration of 1) was used to model emissions from soil to indoor air and groundwater to indoor air.

The indoor air concentrations are presented in Tables B-2.4 and B-2.5 for soil and groundwater, respectively. The risk-based screening criteria for soil and groundwater for exposure to indoor air can then be calculated using the linear relationship between source concentration and predicted indoor air concentration. These values are presented in Tables B-2.4 and B-2.5 for soil and groundwater, respectively.

3. Shower Vapor Volatilization Factors

The potential for chemicals in water to volatilize to shower vapors was estimated using a simulation model described by McKone (1987, 1991). The model evaluates the mass transfer of volatile chemicals from water to air. The model is based on a two-resistance (liquid and gas) approach developed by Mackay and Paterson (1983) in which the rate of chemical transfer from liquid to air is characterized by its mass transfer efficiency. Based on the mass transfer efficiency of radon, the mass transfer efficiencies for volatile organics may be estimated using the following formula derived by Mackay and Paterson (1983):

$$\varphi_i = \varphi_{Rn} \text{ x } \frac{2.0 \text{ x } 10^6 (m^2/s)}{\left[\dfrac{2.5}{D_{li}^{2/3}} + \dfrac{RT}{H_i \text{ x } D_{ai}^{2/3}}\right]}$$

where

φ_i	=	mass transfer efficiency of volatile chemical$_i$ (unitless)
φ_{Rn}	=	mass transfer efficiency for radon = 0.7 (unitless)
D_{li}	=	chemical diffusivity of volatile chemical$_i$ in water (chemical-specific, m^2/s)
D_{ai}	=	chemical diffusivity of volatile chemical$_i$ in air (chemical-specific, m^2/s)
H_i	=	Henry's law constant of volatile chemical$_i$ (chemical-specific, torr - l/mol)
T	=	temperature = 310 (K)
R	=	gas constant = 62.4 (torr - l/mol-K)

It should be noted that within the temperature range likely to be used by humans, the effect of temperature in this equation is negligible. The resulting mass transfer efficiency may be used to estimate volatile emissions during showering via a time independent emissions formula derived from McKone (1987):

$$\text{Emissions (mg/min)} = C_{wi} \text{ x } W_s \text{ x } \varphi_i$$

where

C_{wi}	=	water concentration of volatile chemical$_i$ (chemical-specific, mg/l)
W_s	=	water consumption = 10 (l/min)

The emission rate is a prediction of the rate at which each chemical may diffuse from groundwater during showering into indoor air. After the chemical is released, it will mix with the air in the shower stall where it might be inhaled by potential residential receptors. The shower vapor concentrations to which receptors may be exposed during showering can be estimated using a simple box model, which was also derived from McKone (1987):

$$C_{si} = \frac{\text{Emissions}}{V_s / R_s}$$

where

C_{si}	=	shower air concentration of volatile chemical$_i$ (mg/m^3)
V_s	=	volume of shower stall = 2 (m^3)
R_s	=	residence time of air in shower stall = 20 (minutes)

It is necessary to re-arrange these equations to integrate them into the equation for estimating a RBSC for groundwater used potentially for potable purposes. The second and third equations are combined and re-arranged to solve for a "volatilization factor", or VF, as follows:

$$\frac{C_{si} \times V_s}{R_s} = C_{wi} \text{ x } W_s \text{ x } \varphi_i \quad \text{is re-arranged to} \quad \frac{C_{wi}}{C_{si}} = \frac{V_s}{W_s \times \varphi_i \times R_s}$$

The ratio of C_{wi}/C_{si} can be used as a volatility factor, or VF, in the following form:

$$\text{VF (m}^3\text{/L)} = \frac{V_s}{W_s \times \varphi_i \times R_s}$$

The final equation can be used as a conversion, or volatility, factor in the risk-based groundwater equations to account for volatilization from water to air during showering. The VF, and properties used for each chemical, are provided in Table B-2.6.

It should be noted that the models presented here make some simplifying assumptions, including that the emissions are time independent or steady state.

4. Groundwater Predictions

Risk-based screening criteria in soil for protection of groundwater were calculated using a two-step process. First, a dilution-attenuation factor (DAF) was calculated and applied to the groundwater risk-based screening criteria to predict the pore water concentration allowable for protection of groundwater. Second, equilibrium analysis was used to calculate VOC concentrations in soil due to chemical concentrations in the pore water.

USEPA guidance [1996] was followed to determine the groundwater mixing beneath the Site via use of a dilution attenuation factor (DAF). The USEPA DAF calculation accounts for the physical mixing of the soil porewater with the groundwater as it flows in a horizontal manner. The DAF does not account for adsorption to soils and degradation, which would likely decrease chemical concentrations as the leaching water enters groundwater. Input data for the DAF calculation is provided in Table B-2.3. Using Equation 11 from USEPA [1996], a DAF of 3.5 was calculated.

The porewater concentrations, C_{pw}, were calculated through the following equation:

$$C_{pw} = \text{DAF} * C_{gw}^{RBSC}$$

where:

C_{gw}^{RBSC}	=	Risk based screening criteria in groundwater (μg/L)
C_{pw}	=	Maximum allowable pore water concentration at the water table (μg/L)

Next, the soil equilibrium concentration in the vadose zone is estimated using an equation describing the partitioning between sorbed phase, gas phase, and liquid phase concentrations. The equation, outlined in the USEPA Soil Screening Guidance [USEPA 1996] is as follows:

$$C_s = C_w\left(K_d + \frac{\theta_w + \theta_a H'}{\rho_b}\right)$$

where

C_s	=	soil concentration (milligrams per kilogram [=mg/kg])
C_w	=	water concentration (milligrams per liter [=mg/L])
ρ_b	=	soil bulk density (grams per cubic centimeter [=g/cm^3])
K_d	=	soil-water partition coefficient = K_{oc} x f_{oc} (cubic centimeter per gram [=cm^3/g])
K_{oc}	=	organic carbon partition coefficient (cm^3/g)
f_{oc}	=	organic carbon fraction (dimensionless [-])
θ_w	=	water-filled porosity (cubic centimeter per cubic centimeter [=cm^3/cm^3])
H'	=	Henry's Law constant (-)
θ_a	=	air-filled porosity (cm^3/cm^3)

The porewater concentrations and risk-based screening criteria in soil for protection of groundwater are presented in Table B-2.7.

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Table B-2.1
Physical-Chemical Properties of Detected Organic Chemicals
Former Georgia Pacific California Wood Products Manufacturing Facility
Fort Bragg, California

Chemical	CAS No.	Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant, H ($atm\text{-}m^3/mol$)	Reference temperature, T_R (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Physical state at soil temperature, (S,L,G)
Acenaphthene	83-32-9	4.21E-02	7.69E-06	1.55E-04	25	12,155	550.54	803.15	7.08E+03	3.57E+00	S
Acetone	67-64-1	1.24E-01	1.14E-05	3.87E-05	25	6,955	329.20	508.10	5.75E-01	1.00E+06	L
Benzene	71-43-2	8.80E-02	9.80E-06	5.54E-03	25	7,342	353.24	562.16	5.89E+01	1.79E+03	L
2-Butanone	78-93-3	8.08E-02	9.80E-06	5.58E-05	25	7,481	352.50	536.78	2.30E+00	2.23E+05	L
n-Butylbenzene	104-51-8	5.70E-02	8.12E-06	1.31E-02	25	9,290	456.46	660.50	1.11E+03	2.00E+00	L
sec-Butylbenzene	135-98-8	5.70E-02	8.12E-06	1.39E-02	25	88,730	446.50	679.00	9.66E+02	3.94E+00	L
Carbon disulfide	75-15-0	1.04E-01	1.00E-05	3.02E-02	25	6,391	319.00	552.00	4.57E+01	1.19E+03	L
Chloroform	67-66-3	1.04E-01	1.00E-05	3.66E-03	25	6,988	334.32	536.40	3.98E+01	7.92E+03	L
1,1-Dichloroethane	75-34-3	7.42E-02	1.05E-05	5.61E-03	25	6,895	330.55	523.00	3.16E+01	5.06E+03	L
1,1-Dichloroethene	75-35-4	9.00E-02	1.04E-05	2.60E-02	25	6,247	304.75	576.05	5.89E+01	2.25E+03	L
cis-1,2-Dichloroethene	156-59-2	7.36E-02	1.13E-05	4.07E-03	25	7,192	333.65	544.00	3.55E+01	3.50E+03	L
trans-1,2-Dichloroethe	156-60-5	7.07E-02	1.19E-05	9.36E-03	25	6,717	320.85	516.50	5.25E+01	6.30E+03	L
Ethylbenzene	100-41-4	7.50E-02	7.80E-06	7.86E-03	25	8,501	409.34	617.20	3.63E+02	1.69E+02	L
Fluorene	86-73-7	3.63E-02	7.88E-06	6.34E-05	25	12,666	570.44	870.00	1.38E+04	1.98E+00	S
Isopropylbenzene	98-82-8	6.50E-02	7.10E-06	1.16E+00	25	10,335	425.56	631.10	4.89E+02	6.13E+01	L
para-Isopropyl Toluen	99-87-6	6.00E-02	1.90E-02	9.30E-03	25	10,335	450.00	652.00	5.01E+03	2.80E+01	S
Methylene chloride	75-09-2	1.01E-01	1.17E-05	2.18E-03	25	6,706	313.00	510.00	1.17E+01	1.30E+04	L
2-Methylnaphthalene	91-57-6	5.22E-02	7.75E-06	5.17E-04	25	12,600	514.26	761.00	2.81E+03	2.46E+01	S
MTBE	1634-04-4	1.02E-01	1.05E-05	6.23E-04	25	6,678	328.30	497.10	7.26E+00	5.10E+04	L
Naphthalene	91-20-3	5.90E-02	7.50E-06	4.82E-04	25	10,373	491.14	748.40	2.00E+03	3.10E+01	S
Phenanthrene	85-01-8	5.50E-02	5.90E-06	3.90E-05	25	20,851	614.35	869.30	5.25E+03	1.29E+00	S
Propylbenzene	103-65-1	6.01E-02	7.83E-06	1.07E-02	25	9,123	432.20	630.00	5.62E+02	6.00E+01	L
Tetrachloroethene	127-18-4	7.20E-02	8.20E-06	1.84E-02	25	8,288	394.40	620.20	1.55E+02	2.00E+02	L
Toluene	108-88-3	8.70E-02	8.60E-06	6.62E-03	25	7,930	383.78	591.79	1.82E+02	5.26E+02	L
1,1,1-Trichloroethane	71-55-6	7.80E-02	8.80E-06	1.72E-02	25	7,136	347.24	545.00	1.10E+02	1.33E+03	L
Trichloroethene	79-01-6	7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	L
1,2,4-Trimethylbenzer	95-63-6	6.06E-02	7.92E-06	6.14E-03	25	9,369	442.30	649.17	1.35E+03	5.70E+01	L
1,3,5-Trimethylbenzer	108-67-8	6.02E-02	8.67E-06	5.87E-03	25	9,321	437.89	637.25	1.35E+03	2.00E+00	L
m,p-Xylenes	108-38-3	7.00E-02	7.80E-06	7.32E-03	25	8,523	412.27	617.05	4.07E+02	1.61E+02	L
o-Xylene	95-47-6	8.70E-02	1.00E-05	5.18E-03	25	8,661	417.60	630.30	3.63E+02	1.78E+02	L
TPH C6-C8 [1]	-	8.80E-02	9.80E-06	3.66E-02	25	7,342	353.00	562.16	1.00E+03	2.20E+02	L
TPH C8-C10 [1]	-	6.01E-02	7.83E-06	9.51E-03	25	9,123	423.00	630.00	1.58E+03	6.50E+01	L
TPH C10-C12 [1]	-	5.90E-02	7.50E-06	3.17E-03	25	10,373	473.00	748.40	2.51E+03	2.50E+01	S
TPH C12-C16 [1]	-	5.22E-02	7.75E-06	6.83E-04	25	12,600	533.00	761.00	5.01E+03	5.80E+00	S
TPH C16-C24 [1]	-	5.50E-02	5.90E-06	6.10E-05	25	20,851	593.00	869.30	1.58E+04	6.50E-01	S
TPH C24-C36 [1]	-	4.30E-02	9.00E-06	4.15E-07	25	19,000	613.00	969.27	1.26E+05	6.60E-03	S

Reference: Johnson and Ettinger Model [USEPA 2003], except where noted.

Note:

1. TPH constituent data from TPHCWG, 1997. Data not available for the following properties: diffusivity in air and water; critical temperature; enthalpy of vaporization; and physical state. For these properties, data used from USEPA, 2003 (Johnson and Ettinger model), for the following chemical surrogates: Benzene (TPH C6-C8) , n-Propylbenzene (TPH C8-C10), Napthalene (C10-C12); 2-Methylnaphthalene (TPH C12-C16); Phenanthrene (TPH C16-C24); Benzo(a)pyrene (TPH C24-C36).

Table B-2.2
Measured Soil Physical Data
Former Georgia Pacific California Wood Products Manufacturing Facility
Fort Bragg, California

Boring	Depth (ft bgs)	Moisture Content (% vol)	Total Porosity (% vol)	Bulk Dry Density (g/cm^3)	Effective Air Permeability (cm^2)	Fraction Organic Carbon (-)
GT-1-1.5	1.5	21.11	41.54	1.49	6.6E-09	1.9E-02
GT-1-3.5	3.5	12.07	42.20	1.52	3.5E-08	1.8E-02
GT-2-1.5	1.5	15.26	35.76	1.70	1.1E-08	8.6E-03
GT-2-4.5	4.5	11.51	46.79	1.41	4.8E-08	6.0E-03
GT-3-5.5	5.5	9.94	43.93	1.49	2.9E-08	2.7E-03
GT-4-1.0	1	12.72	38.57	1.62	1.5E-08	4.9E-03
GT-4-10.0	10	24.99	40.57	1.57	3.7E-09	3.2E-03
GT-5-1.5	1.5	21.58	45.19	1.41	8.6E-09	1.4E-02
GT-5-6.5	6.5	14.35	29.47	1.86	1.8E-08	2.4E-03
Site average		15.9	40.4	1.56	1.9E-08	0.0086

Definitions:

ft bgs - Feet below ground surface.
% vol - Percent volume.
g/cm^3 - Grams per cubic centimeter.
cm^2 - Square centimeters.

Table B-2.3
Input Parameters for Fate and Transport Modeling
Former Georgia Pacific California Wood Products Manufacturing Facility
Fort Bragg, California

Variable	Variable name	Units	Value	Notes/ References
Soil properties				
ρ_b	Soil dry bulk density	(g/cm^3)	1.56	1
n	Soil total porosity	(unitless)	0.404	1
q_w	Soil water-filled porosity	(cm^3/cm^3)	0.159	1
f_{oc}	Soil organic carbon fraction	(unitless)	8.62E-03	1
k_v	Soil vapor permeability	(cm^2)	1.94E-08	1
T_S	Average soil temperaure	(^{o}C)	13.9	2
	Depth to groundwater	(ft)	5	3
	Depth to soil samples	(ft)	2	4
I	Infiltration rate	(ft/yr)	2	5
K	Hydraulic conductivity	(cm/s)	1.22E-03	6
i	Hydraulic gradient	(m/m)	3.4E-02	7
d_a	Aquifer thickness	(ft)	19	8
L	Source length	(ft)	1500	9
DAF	Dilution attenuation factor	(-)	3.5	10
Building properties				
L_B	Future Building - Floor length	(cm)	1000	11
W_B	Future Building - Floor width	(cm)	1000	11
H_B	Future Building - Enclosed space height	(cm)	244	12
Q_{soil}	Future Building - Average vapor flow rate into building	(L/m)	5	11
L_{crack}	Floor thickness	(cm)	15	12
w	Floor-wall seam crack width	(cm)	Calculated	11
ER	Residential indoor air exchange rate	(1/h)	0.5	11
DP	Soil-building pressure difference	(g/cm-s^2)	40	11
L_F	Depth to bottom of floor	(cm)	15	11

Notes:

1 - Fort Bragg site-wide average (See Table 2).
2 - Default soil temperature (Figure 8, USEPA 2003).
3 - Ground surface minus water elevation at Site (averaged over all Parcels).
4 - Conservative estimate based on shallow groundwater table.
5 - Calculated with HELP model (Schroeder et al. 1994).
6 - Defualt for Loamy Sand from Johnson & Ettinger model (USEPA 2003).
7 - GW Monitoring Report - average of Sept 04 & Dec 04 from Area 3 to Area 4.
8 - Water elevation minus bedrock elevation at Site.
9 - Length of site in groundwater flow direction (SE).
10 - Calculated using USEPA Soil Screening Guidance (1996) Equation 11.
11 - Vapor Intrusion Guidance (DTSC 2005) defualt.
12 - Johnson & Ettinger model default for building parameters (USEPA 2003).

Table B-2.4
Calculation of Soil Risk Based Screening Criteria Protective of Indoor Air
Former Georgia Pacific California Wood Products Manufacturing Facility
Fort Bragg, California

Chemical	Predicted Indoor Air Concentration[1] (mg/m^3)	Carcinogenic Air RBSC (mg/m^3)	Non-carcinogenic Air RBSC (mg/m^3)	Carcinogenic Soil RBSC (mg/kg)	Non-carcinogenic Soil RBSC (mg/kg)
Acenaphthene	3.59E-05	-	9.39E-02	-	2.62E+03
Acetone	1.51E-02	-	1.41E+00	-	9.34E+01
Benzene	3.05E-01	6.72E-04	1.34E-02	2.20E-03	4.39E-02
2-Butanone	1.52E-02	-	2.23E+00	-	1.47E+02
n-Butylbenzene	2.98E-02	-	6.26E-02	-	2.10E+00
sec-Butylbenzene	7.20E-05	-	6.26E-02	-	8.69E+02
Carbon disulfide	1.98E+00	-	3.13E-01	-	1.58E-01
Chloroform	3.08E-01	3.54E-03	1.56E-02	1.15E-02	5.07E-02
1,1-Dichloroethane	4.75E-01	1.18E-02	2.19E-01	2.48E-02	4.61E-01
1,1-Dichloroethene	1.41E+00	-	8.94E-02	-	6.32E-02
cis-1,2-Dichloroethene	3.16E-01	-	1.56E-02	-	4.95E-02
trans-1,2-Dichloroethene	2.23E+00	-	3.13E-02	-	1.41E-02
Ethylbenzene	6.85E-02	-	4.47E-01	-	6.53E+00
Fluorene	6.99E-06	-	6.26E-02	-	8.95E+03
Isopropylbenzene	3.38E+00	-	1.79E-01	-	5.29E-02
para-Isopropyl Toluene	5.37E-03	-	1.79E-01	-	3.33E+01
Methylene chloride	4.08E-01	1.92E-02	1.34E+00	4.70E-02	3.28E+00
2-Methylnaphthalene	3.36E-04	-	1.34E-03	-	3.99E+00
MTBE	1.46E-01	7.39E-02	1.34E+00	5.05E-01	9.17E+00
Naphthalene	5.84E-04	5.60E-04	1.34E-03	9.59E-01	2.29E+00
Phenanthrene	6.32E-06	-	1.34E-03	-	2.12E+02
Propylbenzene	5.02E-02	-	6.26E-02	-	1.25E+00
Tetrachloroethene	3.53E-01	3.20E-03	1.56E-02	9.07E-03	4.43E-02
Toluene	1.27E-01	-	1.79E-01	-	1.41E+00
1,1,1-Trichloroethane	5.14E-01	-	9.86E-01	-	1.92E+00
Trichloroethene	2.35E+00	9.61E-03	1.56E-02	4.09E-03	6.66E-03
1,2,4-Trimethylbenzene	1.20E-02	-	2.66E-03	-	2.21E-01
1,3,5-Trimethylbenzene	1.15E-02	-	2.66E-03	-	2.32E-01
m,p-Xylenes	5.49E-02	-	4.47E-02	-	8.14E-01
o-Xylene	4.76E-02	-	4.47E-02	-	9.39E-01
TPH C6-C8	9.59E-02	-	1.79E-01	-	1.86E+00
TPH C8-C10	1.65E-02	-	1.79E-01	-	1.09E+01
TPH C10-C12	5.21E-03	-	8.94E-02	-	1.72E+01
TPH C12-C16	7.85E-04	-	8.94E-02	-	1.14E+02

Definitions:

mg/m^3 - Milligrams per cubic meter.
mg/kg - Milligrams per kilogram.

Notes:

1 - Unitary source concentration used.

Table B-2.5
Calculation of Groundwater Risk Based Screening Criteria Protective of Indoor Air
Former Georgia Pacific California Wood Products Manufacturing Facility
Fort Bragg, California

Chemical	Predicted Indoor Air Concentration[1] (mg/m^3)	Carcinogenic Air RBSC (mg/m^3)	Non-carcinogenic Air RBSC (mg/m^3)	Carcinogenic Groundwater RBSC (ug/l)	Non-carcinogenic Groundwater RBSC (ug/l)
Acetone	7.43E-07	-	1.41E+00	-	1.90E+06
Benzene	3.90E-05	6.72E-04	1.34E-02	1.72E+01	3.44E+02
Carbon disulfide	2.66E-04	-	3.13E-01	-	1.18E+03
Chloroform	3.11E-05	3.54E-03	1.56E-02	1.14E+02	5.03E+02
1,1-Dichloroethane	3.56E-05	1.18E-02	2.19E-01	3.32E+02	6.16E+03
1,1-Dichloroethene	2.06E-04	-	8.94E-02	-	4.34E+02
cis-1,2-Dichloroethene	2.55E-05	-	1.56E-02	-	6.14E+02
MTBE	5.94E-06	7.39E-02	1.34E+00	1.24E+04	2.26E+05
Naphthalene	2.24E-06	5.60E-04	1.34E-03	2.50E+02	5.98E+02
n-Propylbenzene	4.28E-05	-	6.26E-02	-	1.46E+03
Tetrachloroethene	9.71E-05	3.20E-03	1.56E-02	3.30E+01	1.61E+02
1,1,1-Trichloroethane	1.09E-04	-	9.86E-01	-	9.06E+03
Trichloroethene	6.34E-05	9.61E-03	1.56E-02	1.52E+02	2.47E+02
TPH C6-C8	2.53E-04	-	1.79E-01	-	7.06E+02
TPH C8-C10	3.90E-05	-	1.79E-01	-	4.59E+03
TPH C10-C12	1.21E-05	-	8.94E-02	-	7.39E+03
TPH C12-C16	2.22E-06	-	8.94E-02	-	4.03E+04

Definitions:

ug/l - Micrograms per liter.

mg/m^3 - Milligrams per cubic meter.

Notes:

1 - Unitary source concentration used.

Table B.2-6
Shower Vapor Volatilization Factor Calculations
Georgia Pacific Corporation
Fort Bragg, California

COPC	Diffusivity in Water (m^2/s) D_{li}	Diffusivity in Air (m^2/s) D_{ai}	Henry's Law Constant (torr-L/mol) H_i	Mass Transfer Efficiency (-) φ_i	Shower Water Discharge Rate (l/min) C_{si}	Shower Stall Volume (m^3) V_s	Shower Stall Air Residence Time (min) R_s	VF = $\frac{V_s}{W_s \times \varphi_i \times R_s}$
Acetone	1.14E-09	1.24E-05	2.94E+01	3.98E-01	10	2	20	2.513E-02
Benzene	9.80E-10	8.80E-06	4.21E+03	5.50E-01	10	2	20	1.818E-02
Carbon disulfide	1.00E-09	1.04E-05	2.30E+04	5.60E-01	10	2	20	1.787E-02
Chloroform	1.00E-09	1.04E-05	2.78E+03	5.57E-01	10	2	20	1.796E-02
1,1-Dichloroethane	1.05E-09	7.42E-06	4.26E+03	5.76E-01	10	2	20	1.737E-02
1,1-Dichloroethene	1.04E-09	9.00E-06	1.98E+04	5.74E-01	10	2	20	1.741E-02
cis-1,2-Dichloroethene	1.13E-09	7.36E-06	3.09E+03	6.03E-01	10	2	20	1.658E-02
Methyl-tert-butyl ether	1.05E-09	1.02E-05	4.74E+02	5.59E-01	10	2	20	1.790E-02
Naphthalene	7.50E-10	5.90E-06	3.66E+02	4.39E-01	10	2	20	2.279E-02
Propylbenzene	7.83E-10	6.01E-06	8.10E+03	4.75E-01	10	2	20	2.107E-02
Tetrachloroethene	8.20E-10	7.20E-06	1.39E+04	4.90E-01	10	2	20	2.041E-02
1,1,1-Trichloroethane	8.80E-10	7.80E-06	1.30E+04	5.14E-01	10	2	20	1.947E-02
TPH C6-C8	9.80E-10	8.80E-06	2.78E+04	5.52E-01	10	2	20	1.811E-02
TPH C8-C10	7.83E-10	6.01E-06	7.23E+03	4.74E-01	10	2	20	2.108E-02
TPH C10-C12	7.50E-10	5.90E-06	2.41E+03	4.59E-01	10	2	20	2.181E-02
TPH C12-C16	7.75E-10	5.22E-06	5.19E+02	4.54E-01	10	2	20	2.205E-02
Trichloroethene	9.10E-10	7.90E-06	7.81E+03	5.25E-01	10	2	20	1.906E-02

Defintions:
l/min = liter per minute
m^2/s = squre meters per second
m^3 = cubic meters
min = minute
mol = a unit of amount of substance, (e.g., a number whose mass in grams is equal numerically to the atomic wight, movlecular weight, or formula weight)
torr-L/mol = torr- liter per mol
torr = a unit of pressure

Notes:
1 atmosphere = 760 torr
1 m^3 = 1000 L
torr-L/mol = atm-m^3/mol x 760 atm x 1000 L

Table B-2.7
Calculation of Soil Risk Based Screening Criteria Protective of Groundwater
Former Georgia Pacific California Wood Products Manufacturing Facility
Fort Bragg, California

	Carcinogenic			Non-Carcinogenic		
Chemical	**Risk Based Screening Criteria (RBSC) (ug/l)**	**Porewater Concentration (ug/l)[1]**	**Carcinogenic Soil RBSC (mg/kg)**	**Risk Based Screening Criteria (RBSC) (ug/l)**	**Porewater Concentration (ug/l)[1]**	**Non-carcinogenic Soil RBSC (mg/kg)**
Acenaphthene	-	-	-	5.72E+02	2.00E+03	1.22E+02
Acetone	-	-	-	8.71E+03	3.05E+04	3.28E+00
Benzene	1.45E+00	5.06E+00	3.27E-03	5.20E+01	1.82E+02	1.17E-01
2-Butanone	-	-	-	1.03E+04	3.62E+04	4.43E+00
n-Butylbenzene	-	-	-	2.99E+02	1.04E+03	1.02E+01
sec-Butylbenzene	-	-	-	3.13E+02	1.10E+03	9.35E+00
Carbon disulfide	-	-	-	1.23E+03	4.30E+03	2.97E+00
Chloroform	6.66E+00	2.33E+01	1.09E-02	7.47E+01	2.62E+02	1.23E-01
1,1-Dichloroethane	2.46E+01	8.60E+01	3.53E-02	9.43E+02	3.30E+03	1.36E+00
1,1-Dichloroethene	-	-	-	4.04E+02	1.41E+03	1.10E+00
cis-1,2-Dichloroethene	-	-	-	7.01E+01	2.45E+02	1.07E-01
trans-1,2-Dichloroethene	-	-	-	1.36E+02	4.76E+02	2.92E-01
Ethylbenzene	-	-	-	1.64E+03	5.74E+03	1.88E+01
Fluorene	-	-	-	4.47E+02	1.56E+03	1.86E+02
Isopropylbenzene	-	-	-	9.50E+02	3.32E+03	3.91E+01
para-Isopropyl Toluene	-	-	-	9.57E+02	3.35E+03	1.45E+02
Methylene chloride	2.38E+01	8.33E+01	1.81E-02	1.68E+03	5.87E+03	1.28E+00
2-Methylnaphthalene	-	-	-	9.27E+00	3.25E+01	7.90E-01
MTBE	1.31E+02	4.57E+02	7.71E-02	1.82E+02	6.38E+02	1.08E-01
Naphthalene	1.94E+00	6.79E+00	1.18E-01	1.01E+01	3.53E+01	6.13E-01
Phenanthrene	-	-	-	1.76E+01	6.16E+01	2.79E+00
Propylbenzene	-	-	-	3.30E+02	1.16E+03	5.80E+00
Tetrachloroethene	1.04E+00	3.65E+00	5.69E-03	8.18E+01	2.86E+02	4.46E-01
Toluene	-	-	-	1.01E+03	3.55E+03	6.09E+00
1,1,1-Trichloroethane	-	-	-	3.92E+03	1.37E+04	1.59E+01
Trichloroethene	1.79E+01	6.28E+01	1.00E-01	9.72E+00	3.40E+01	5.44E-02
1,2,4-Trimethylbenzene	-	-	-	1.85E+01	6.46E+01	7.63E-01
1,3,5-Trimethylbenzene	-	-	-	1.74E+01	6.09E+01	7.19E-01
m,p-Xylenes	-	-	-	3.03E+02	1.06E+03	3.87E+00
o-Xylene	-	-	-	2.59E+02	9.05E+02	2.95E+00
TPH C6-C8	-	-	-	9.32E+02	3.26E+03	2.92E+01
TPH C8-C10	-	-	-	6.54E+02	2.29E+03	3.17E+01
TPH C10-C12	-	-	-	4.39E+02	1.54E+03	3.35E+01
TPH C12-C16	-	-	-	4.45E+02	1.56E+03	6.75E+01
TPH C16-C24	-	-	-	1.03E+03	3.60E+03	4.93E+02

Definitions:

ug/l - Micrograms per liter.
mg/kg - Milligrams per kilogram.

Notes:

1 - Porewater concentration is RBSC x groundwater DAF (3.5).

APPENDIX B
ATTACHMENT B-3

RSBC – SUPPORTING INFORMATION

Table B-3.1
Oral Carcinogenic Slope Factors
Georgia Pacific Corporation
Fort Bragg, California

Chemical	Oral Slope Factor $(mg/kg/day)^{-1}$	Weight of Evidence	Tumor	Test Species	Slope Factor Source	Date
METALS						
Antimony	-	-	-	-	1	-
Arsenic	9.45E+00	A	Lung	Human	Cal EPA	Dec-05
Barium	-	D	-	-	-	-
Beryllium	-	B1	-	-	2	-
Cadmium	-	B1	-	-	3	-
Chromium	-	D	-	-	-	-
Cobalt	-	-	-	-	2	-
Copper	-	D	-	-	-	-
Lead	-	B2	-	-	4	-
Mercury	-	-	-	-	3	-
Molybdenum	-	-	-	-	1	-
Nickel	-	-	-	-	2	-
Selenium	-	D	-	-	-	-
Silver	-	D	-	-	-	-
Thallium	-	D	-	-	-	-
Vanadium	-	-	-	-	1	-
Zinc	-	D	-	-	-	-
Volatile Organic Compounds (VOCs)						
Acetone	-	-	-	-	1	-
Benzene	1.00E-01	A	Leukemia	Human	Cal EPA	Dec-05
2-Butanone	-	-	-	-	3	
n-Butylbenzene	-	-	-	-	3	-
sec-Butylbenzene	-	-	-	-	1	-
Carbon disulfide	-	-	-	-	5	-
Chloroform	3.10E-02	B2	Kidney	Rat; Mouse	Cal EPA	Dec-05
1,1-Dichloroethane	5.70E-03	B2	Hemangiosarcomas	Mouse (Male)	Cal EPA	Dec-05
1,1-Dichloroethene	-	C	-	-	5	-
cis-1,2-Dichloroethene	-	D	-	-	1	-
trans-1,2-Dichloroethene	-	-	-	-	5	-
Ethylbenzene	-	-	-	-	5	-
Freon 113	-	-	-	-	5	-
Isopropanol (Isopropyl alchoho	-	-	-	-	5	-
Isopropylbenzene	-	-	-	-	5	-
para-Isopropyl Toluene	-	D	-	-	5	-
Methylene chloride	1.40E-02	B2	Lung	Mouse	Cal EPA	Dec-05
MTBE	1.80E-03	C	Kidney adenomas; leukemia & lymphomas	Rat	Cal EPA	Dec-05
Propylbenzene	-	-	-	-	1	-
Tetrachloroethene (PCE)	5.40E-01	-	Liver	Mouse	Cal EPA	Dec-05
Toluene	-	-	-	-	5	-
1,1,1-Trichloroethane	-	-	-	-	5	-
Trichloroethene (TCE)	1.30E-02	B2	Liver	Mouse	Cal EPA	Dec-05
1,2,4-Trimethylbenzene	-	-	-	-	5	-
1,3,5-Trimethylbenzene	-	-	-	-	5	-
m,p-Xylenes	-	-	-	-	5	-
o-Xylene	-	-	-	-	5	-
Semi-Volatile Organic Compounds (SVOCs)						
Acenaphthene	-	-	-	-	5	-
Benzo(a)anthracene	1.20E+00	B2	Skin, lung	Mouse	Cal EPA	Dec-05
Benzo(b)fluoranthene	1.20E+00	B2	Skin	Mouse	Cal EPA	Dec-05
Benzo(k)fluoranthene	1.20E+00	B2	Skin	Mouse	Cal EPA	Dec-05
Benzoic acid	-	D	-	-	5	-

Table B-3.1
Oral Carcinogenic Slope Factors
Georgia Pacific Corporation
Fort Bragg, California

Chemical	Oral Slope Factor $(mg/kg/day)^{-1}$	Weight of Evidence	Tumor	Test Species	Slope Factor Source	Date
Chrysene	1.20E-01	B2	Mammary gland	Mouse	Cal EPA	Dec-05
Flouranthene	-	-	-	-	5	-
Fluorene	-	-	-	-	5	-
2-Methylnaphthalene	-	-	-	-	5	-
Naphthalene	-	-	-	-	5	-
N-Nitrosodiphenylamine	9.00E-03				Cal EPA	Dec-05
Phenanthrene	-	-	-	-	5	-
Phenol	-	-	-	-	5	-
Pyrene	-	-	-	-	5	-
Polychlorinated Biphenyls (PCBs)						
PCB	5	B2	Liver	Rat	Cal EPA	Dec-05
Dioxins and Furans						
TCDD	1.E+05	-	Liver	Mouse	Cal EPA	Dec-05
Total Petroleum Hydrocarbons (TPH)						
TPH C6-C8	-	-	-	-	5	-
TPH C8-C10	-	-	-	-	5	-
TPH C10-C12	-	-	-	-	5	-
TPH C12-C16	-	-	-	-	5	-
TPH C16-C24	-	-	-	-	5	-
TPH C24-C36	-	-	-	-	5	-

Definitions:

A - Chemical cancer classification (human carcinogen).
B1 - Chemical cancer classification (probable human carcinogen; limited human evidence).
B2 - Chemical cancer classification (probabale human carcinogen; sufficient animal evidence and/or no human evidence).
Cal EPA - California Environmental Protection Agency.
D - Chemical cancer classification (not classifiable as to carcinogenicity).
IRIS - Integrated Risk Information System.
$(mg/kg/day)^{-1}$ - Risk per milligram per kilogram per day.
TCDD - 2,3,7,8-Tetrachlorodibenzo-p-dioxin and related compounds
USEPA - United States Environmental Protection Agency

Table B-3.1
Inhalation Carcinogenic Slope Factors
Georgia Pacific Corporation
Fort Bragg, California

CHEMICAL	Inhalation Slope Factor (mg/kg/day)$^{-1}$	Weight of Evidence	Tumor	Test Species	Slope Factor Source	Date
METALS						
Antimony	-	-	-	-	1	-
Arsenic	1.20E+01	A	Lung	Human	Cal EPA	Dec-05
Barium	-	D	-	-	-	-
Beryllium	8.40E+00	B1	Lung	Human	Cal EPA	Dec-05
Cadmium	1.50E+01	B1	Lung	Human	Cal EPA	Dec-05
Chromium	-	D	-	-	-	-
Cobalt	9.80E+00	-	-	-	PRG	Oct-04
Copper	-	D	-	-	-	-
Lead	-	B2	-	-	2	-
Mercury	-	C	-	-	1	-
Molybdenum	-	-	-	-	3	-
Nickel	9.10E-01	-	Lung	Human	Cal EPA	Dec-05
Selenium	-	D	-	-	-	-
Silver	-	D	-	-	-	-
Thallium	-	D	-	-	-	-
Vanadium	-	-	-	-	3	-
Zinc	-	D	-	-	-	-
Volatile Organic Compounds (VOCs)						
Acetone	-	-	-	-	3	-
Benzene	1.00E-01	A	Leukemia	Human	Cal EPA	Dec-05
2-Butanone	-	-	-	-	1	-
n-Butylbenzene	-	-	-	-	1	-
sec-Butylbenzene	-	-	-	-	1	-
Carbon disulfide	-	-	-	-	1	-
Chloroform	1.90E-02	B2	Kidney	Rat; Mouse	Cal EPA	Dec-05
1,1-Dichloroethane	5.70E-03	C	Mammary gland adenocarcinoma	Rat	Cal EPA	Dec-05
1,1-Dichloroethene	-	-	-	-	1	-
cis-1,2-Dichloroethene	-	D	-	-	-	-
trans-1,2-Dichloroethene	-	-	-	-	3	-
Ethylbenzene	-	-	-	-	1	-
Freon 113	-	-	-	-	1	-
Isopropanol (Isopropyl alchc	-	-	-	-	1	-
Isopropylbenzene	-	-	-	-	1	-
para-Isopropyl Toluene	-	-	-	-	1	-
Methylene chloride	3.50E-03	B2	Lung	Mouse	Cal EPA	Dec-05
MTBE	9.10E-04	–	Leukemia and lymphomas	Rat	Cal EPA	Dec-05
Propylbenzene	-	-	-	-	1	-
Tetrachloroethene (PCE)	2.10E-02	B2	Liver	Mouse	Cal EPA	Dec-05
Toluene	-	D	-	-	-	-
1,1,1-Trichloroethane	-	-	-	-	1	-
Trichloroethene (TCE)	7.00E-03	B2	Liver, lung, lymphoma	Mouse	Cal EPA	Dec-05
1,2,4-Trimethylbenzene	-	-	-	-	1	-
1,3,5-Trimethylbenzene	-	-	-	-	1	-
m,p-Xylenes	-	D	-	-	1	-
o-Xylene	-	D	-	-	1	-
Semi-Volatile Organic Compounds (SVOCs)						
Acenaphthene	-	-	-	-	1	-
Benzo(a)anthracene	3.90E-01	B2	Skin, lung	Mouse	Cal EPA	Dec-05

Table B-3.1
Inhalation Carcinogenic Slope Factors
Georgia Pacific Corporation
Fort Bragg, California

CHEMICAL	Inhalation Slope Factor $(mg/kg/day)^{-1}$	Weight of Evidence	Tumor	Test Species	Slope Factor Source	Date
Benzo(b)fluoranthene	3.90E-01	B2	Skin	Mouse	Cal EPA	Dec-05
Benzo(k)fluoranthene	3.90E-01	B2	Skin	Mouse	Cal EPA	Dec-05
Benzoic acid	-	-	-	-	1	-
Chrysene	3.90E-02	B2	Skin	Mouse	Cal EPA	Dec-05
Flouranthene	-	-	-	-	1	-
Fluorene	-	-	-	-	1	-
2-Methylnaphthalene	-	-	-	-	1	-
Naphthalene	1.20E-01	C	Nasal	Rat	Cal EPA	Dec-05
N-Nitrosodiphenylamine	9.00E-03				Cal EPA	Dec-05
Phenanthrene	-	-	-	-	1	-
Phenol	-	-	-	-	1	-
Pyrene	-	-	-	-	1	-
Polychlorinated Biphenyls (PCBs)						
PCB	2	B2	Liver	Rat	Cal EPA	Dec-05
Dioxins and Furans						
TCDD	1.E+05	-	Liver	Mouse	Cal EPA	Dec-05
Total Petroleum Hydrocarbons (TPH)						
TPH C6-C8	-	-	-	-	1	-
TPH C8-C10	-	-	-	-	1	-
TPH C10-C12	-	-	-	-	1	-
TPH C12-C16	-	-	-	-	1	-
TPH C16-C24	-	-	-	-	1	-
TPH C24-C36	-	-	-	-	1	-

Definitions:

A - Chemical cancer classification (human carcinogen).
B1 - Chemical cancer classification (probable human carcinogen; limited human evidence).
B2 - Chemical cancer classification (probabale human carcinogen; sufficient animal evidence and/or nc
- evidence).
Cal EPA - California Environmental Protection Agency.
D - Chemical cancer classification (not classifiable as to carcinogenicity).
IRIS - Integrated Risk Information System.
$(mg/kg/day)^{-1}$ - Risk per milligram per kilogram per day.
PRG - Preliminary remediation goal table (Region 9 USEPA, 2004)
TCDD - 2,3,7,8-Tetrachlorodibenzo-p-dioxin and related compounds
USEPA - United States Environmental Protection Agency

Notes:

All weight of evidence classifications were obtained from USEPA (2005a) Integrated Risk Information System (IRIS).
1 - No SFs available from USEPA or CalEPA
2 - Lead assessed using Leadspread v7.0 (DTSC 2000b) and the USEPA (2003b) Adult Lead Model (
3 - This chemical has not been demonstrated to be carcinogenic.

Table B-3.3
Oral Noncarcinogenic Reference Doses
Georgia Pacific Corporation
Fort Bragg, California

Chemical	(mg/kg/day)	Confidence	MF	UF	Critical Effect	Test Species	Source	Date
METALS								
Antimony	4.00E-04	Low	1	1,000	Longevity, blood glucose, and cholesterol	Rat	IRIS	Dec-05
Arsenic	3.00E-04	Medium	1	3	Hyperpigmentation, keratosis, and possible vascular complications	Human	IRIS	Dec-05
Barium	2.00E-01	Medium	1	300	Nephropathy	Mouse	IRIS	Dec-05
Beryllium	2.00E-03	Low/Mediun	1	300	Small intestinal legions	Dog	IRIS	Dec-05
Cadmium	1.00E-03	High	1	10	Proteinuria	Human	IRIS	Dec-05
Chromium	1.50E+00	Low	10	100	No effects observed	Rat	IRIS	Dec-05
Cobalt	2.00E-02	-	-	-	-	-	PRG	Oct-04
Copper	4.00E-02	-	-	-	Gastro-intestinal irritation	Human	HEAST; 1	Jul-97
Lead	-	-	-	-	-	-	2	-
Mercury	3.00E-04	High	1	1,000	Autoimmune effects	Rat	IRIS	Dec-05
Molybdenum	5.00E-03	Medium	1	30	Increased uric acid levels	Human	IRIS	Dec-05
Nickel	2.00E-02	Medium	1	300	Decreased body and organ weights	Rat	IRIS	Dec-05
Selenium	5.00E-03	High	1	3	Clinical selenosis	Human	IRIS	Dec-05
Silver	5.00E-03	Low	1	3	Argyria	Human	IRIS	Dec-05
Thallium	8.00E-05	Low	1	3,000	No adverse effects	Rat	IRIS	Dec-05
Vanadium	7.00E-03	-	-	100	None given	Rat	HEAST	Jul-97
Zinc	3.00E-01	Medium/Hig	1	3	Decreases in erythrocyte Cu, Zn-superoxide dismutase (ESOD) activity	Human	IRIS	Dec-05
Volatile Organic Compounds (VOCs)								
Acetone	9.00E-01	Medium	1	1000	Nephropathy	Rat	IRIS	Dec-05
Benzene	4.00E-03	Medium	1	300	Decreased lymphocyte count	Human	IRIS	Dec-05
2-Butanone	6.00E-01	Low	1	1000	Decreased pup body weight	Rats	IRIS	Dec-05
n-Butylbenzene	4.00E-02	-	-	-	-	-	PRG	Oct-04
sec-Butylbenzene	4.00E-02	-	-	-	-	-	PRG	Oct-04
Carbon disulfide	1.00E-01	Medium	1	100	Fetal toxicity/ malformations	Rat	IRIS	Dec-05
Chloroform	1.00E-02	Medium	1	100	Moderate/marked fatty cyst formation in the liver and elevated SGPT	Dog	IRIS	Dec-05
1,1-Dichloroethane	1.00E-01	-	-	1,000	No effects observed	Rat	HEAST	Jul-97
1,1-Dichloroethene	5.00E-02	Medium	1	100	Liver toxicity (fatty change)	Rat	IRIS	Dec-05
cis-1,2-Dichloroethene	1.00E-02	-	-	3,000	Decreased hematocrit and hemoglobin	Rat	HEAST	Jul-97
trans-1,2-Dichloroethene	2.00E-02	Low	1	1,000	Increase in serum alkaline phosphatase in male mice	Mouse	IRIS	Dec-05
Ethylbenzene	1.00E-01	Low	1	1000	Liver and kidney toxicity	Rat	IRIS	Dec-05
Freon 113	-	-	-	-	-	-	3	-
Isopropanol (Isopropyl alchoho	-	-	-	-	-	-	3	-
Isopropylbenzene	1.00E-01	Low	1	1000	Increased kidney weight in females	Rat	IRIS	Dec-05
para-Isopropyl Toluene	1.00E-01	-	-	-	-	-	4	-
Methylene chloride	6.00E-02	Medium	1	100	Liver toxicity	Rat	IRIS	Dec-05
MTBE	-	-	-	-	-	-	3	-
Propylbenzene	4.00E-02	-	-	-	-	-	PRG	Oct-04
Tetrachloroethene (PCE)	1.00E-02	Medium	1	1,000	Liver toxicity	Mouse, Rat	IRIS	Dec-05
Toluene	2.00E-01	Medium	1	3,000	Liver and kidney weight changes	Rat	IRIS	Dec-05
1,1,1-Trichloroethane	2.80E-01	-	-	-	-	-	PRG	Oct-04
Trichloroethene (TCE)	3.00E-04	-	-	-	-	-	PRG	Oct-04
1,2,4-Trimethylbenzene	5.00E-02	-	-	-	-	-	PRG	Oct-04
1,3,5-Trimethylbenzene	5.00E-02	-	-	-	-	-	PRG	Oct-04
m,p-Xylenes	2.00E-01	Medium	1	1000	Decreased body weight, increased mortality	Rat	IRIS	Dec-05
o-Xylene	2.00E-01	Medium	1	1000	Decreased body weight, increased mortality	Rat	IRIS	Dec-05
Semi-Volatile Organic Compounds (SVOCs)								
Acenaphthene	6.00E-02	Low	1	3000	Liver toxicity	Mouse	IRIS	Dec-05
Benzo(a)anthracene	2.00E-02	-	-	-	-	-	5	-
Benzo(b)fluoranthene	2.00E-02	-	-	-	-	-	5	-
Benzo(k)fluoranthene	2.00E-02	-	-	-	-	-	5	-
Benzoic acid	4.00E+00	Medium	1	1	No adverse effects observed	Human	IRIS	Dec-05
Chrysene	2.00E-02	-	-	-	-	-	5	-
Flouranthene	4.00E-02	Low	1	3000	Nephropathy, increased liver weights, hematological alterations, and clinical effects	Mouse	IRIS	Dec-05

Table B-3.3
Oral Noncarcinogenic Reference Doses
Georgia Pacific Corporation
Fort Bragg, California

Chemical	(mg/kg/day)	Confidence	MF	UF	Critical Effect	Test Species	Source	Date
Fluorene	4.00E-02	Low	1	3000	Decreased RBCs, packed cell volume and hemoglobin	Mouse	IRIS	Dec-05
2-Methylnaphthalene	4.00E-03	Low	1	1000	Pulmonary alveolar proteinosis	Mice	IRIS	Dec-05
Naphthalene	2.00E-02	Low	1	3000	Decreased mean body weight	Rat	IRIS	Dec-05
N-Nitrosodiphenylamine	2.00E-02	-	-	-	-	-	PRG	Oct-04
Phenol	3.00E-01	Medium	1	300	Decreased maternal weight gain	Rat	IRIS	Dec-05
Phenanthrene	2.00E-02	-	-	-	-	-	5	-
Pyrene	3.00E-02	Low	1	3000	Renal tubular pathology, decreased kidney weight	Mouse	IRIS	Dec-05
Polychlorinated Biphenyls (PCBs)								
PCB -	7.00E-05	Medium	1	300	Ocular exudate, inflamed and prominent Meibomian glands, distorted growth of finger and toe nails; decreased antibody response	Monkey	IRIS, 6	Dec-05
Dioxins and Furans								
TCDD	-	-	-	-	-	-	3	-
Total Petroleum Hydrocarbons (TPH)								
TPH C6-C8	0.2	-	-	-	Hepatoxicity; Nephrotoxicity	-	TPHCWG, 7	1997
TPH C8-C10	0.04	-	-	-	Hepatoxicity; Nephrotoxicity	-	TPHCWG, 7	1997
TPH C10-C12	0.04	-	-	-	Decreased body weight	-	TPHCWG, 7	1997
TPH C12-C16	0.04	-	-	-	Decreased body weight	-	TPHCWG, 7	1997
TPH C16-C24	0.03	-	-	-	Nephrotoxicity	-	TPHCWG, 8	1997
TPH C24-C36	0.03	-	-	-	Nephrotoxicity	-	TPHCWG, 9	1997

Definitions:

DTSC - Department of Toxic Substances Control.
HEAST - Health Effects Assessment Summary Tables.
IRIS - Integrated Risk Information System.
TPHCWG - Total Petroleum Hydrocarbon Criteria Working Group Series
MF - Modifying factor.
mg/kg/day - Milligram per kilogram per day.
PRG - Preliminary remediation goal table (Region 9 USEPA, 2004)
RfD - Reference dose.
UF - Uncertainty factor.
TCDD - 2,3,7,8-Tetrachlorodibenzo-p-dioxin and related compounds

Notes:

1 - Based on drinking water criterion of 1.3 mg/L.
2 - Lead assessed using Leadspread v7.0 (DTSC 2000b) and the USEPA (2003b) Adult Lead Model (ALM).
3 - No RfDs available from IRIS or HEAST.
4 - Isopropylbenzene used as a surrogate
6 - Aroclor 1254 used as a surrogate for PCB (Aroclor) mixtures
5 - Naphthalene used as a surrogate
7 - Aromatic oral RfD selected as more health protective.
8 - C16-C21 used as a surrogate
9 C21-C35 used as a surrogate

Table B-3.4
Inhalation Noncarcinogenic Reference Doses
Georgia Pacific Corporation
Fort Bragg, California

Chemical	RfD (mg/kg/day)	RfC (mg/m^3)	Confidence	MF	UF	Critical Effect	Test Species	Source	Date
METALS									
Antimony	4.00E-04	-	-	-	-	-	-	1	-
Arsenic	3.00E-04	-	-	-	-	-	-	1	-
Barium	-	-	-	-	-	-	-	IRIS;2	Dec-05
Beryllium	5.71E-06	2.00E-5	Medium	1	10	Beryllium sensitization and progression to CBD	Human	IRIS	Dec-05
Cadmium	5.00E-04	-	-	-	-	-	-	1	-
Chromium	1.50E+00	-	-	-	-	-	-	1	-
Cobalt	5.70E-06	-	-	-	-	-	-	PRG	Oct-04
Copper	4.00E-02	-	-	-	-	-	-	1	-
Lead	-	-	-	-	-	-	-	3	-
Mercury	3.00E-04	-	-	-	-	-	-	1	-
Molybdenum	5.00E-03	-	-	-	-	-	-	1	-
Nickel	2.00E-02	-	-	-	-	-	-	1	-
Selenium	5.00E-03	-	-	-	-	-	-	1	-
Silver	5.00E-03	-	-	-	-	-	-	1	-
Thallium	8.00E-05	-	-	-	-	-	-	1	-
Vanadium	7.00E-03	-	-	-	-	-	-	1	-
Zinc	3.00E-01	-	-	-	-	-	-	1	-
Volatile Organic Compounds (VOCs)									
Acetone	9.00E-01	-	-	-	-	-	-	1	-
Benzene	8.57E-03	0.03	Medium	1	300	Decreased lymphocyte count	Human	IRIS	Dec-05
2-Butanone	1.43E+00	5	Medium	1	300	Developmental toxicity (skeletal variations)	Mice	IRIS	Dec-05
n-Butylbenzene	4.00E-02	-	-	-	-	-	-	1	-
sec-Butylbenzene	4.00E-02	-	-	-	-	-	-	1	-
Carbon disulfide	2.00E-01	0.7	Medium	1	30	Peripheral nervous system dysfunction	Human	IRIS	Dec-05
Chloroform	1.00E-02	-	-	-	-	-	-	1	-
1,1-Dichloroethane	1.40E-01	-	-	-	1,000	Kidney damage	Cat	HEAST	Jul-97
1,1-Dichloroethene	5.71E-02	2.00E-01	Medium	1	30	Liver toxicity (fatty change	Rat	IRIS	Dec-05
cis-1,2-Dichloroethene	1.00E-02	-	-	-	-	-	-	1	-
trans-1,2-Dichloroethene	2.00E-02	-	-	-	-	-	-	1	-
Ethylbenzene	2.86E-01	1	Low	1	300	Developmental toxicity	Rat, rabbit	IRIS	Dec-05
Freon 113	-	-	-	-	-	-	-	4	-
Isopropanol (Isopropyl alchohol)	-	-	-	-	-	-	-	4	-
Isopropylbenzene	1.14E-01	0.4	Medium	1	1,000	Increased kidney weights in females; increased adrenal weights in both sexes	Rat	IRIS	Dec-05
para-Isopropyl Toluene	1.14E-01	-	-	-	-	-	-	5	-
Methylene chloride	8.57E-01	-	-	-	-	Cardiovascular system; nervous system	Human	HEAST	Jul-97
MTBE	8.57E-01	3	Medium	1	1000	Liver and kidney	Rat	IRIS	Dec-05
Propylbenzene	4.00E-02	-	-	-	-	-	-	1	-
Tetrachloroethene (PCE)	1.00E-02	-	-	-	-	-	-	1	-
Toluene	1.14E-01	5	High	1	10	Neurological Effects	Human	IRIS	Dec-05
1,1,1-Trichloroethane	6.30E-01	-	-	-	-	-	-	PRG	Oct-04
Trichloroethene (TCE)	1.00E-02	-	-	-	-	-	-	PRG	Oct-04
1,2,4-Trimethylbenzene	1.70E-03	-	-	-	-	-	-	PRG	Oct-04
1,3,5-Trimethylbenzene	1.70E-03	-	-	-	-	-	-	PRG	Oct-04
m,p-Xylenes	2.86E-02	0.1	-	1	300	Impaired motor coordination (decreased rotarod performance)	Rat	IRIS	Dec-05

Table B-3.4
Inhalation Noncarcinogenic Reference Doses
Georgia Pacific Corporation
Fort Bragg, California

Chemical	RfD (mg/kg/day)	RfC (mg/m³)	Confidence	MF	UF	Critical Effect	Test Species	Source	Date
o-Xylene	2.86E-02	0.1	-	1	300	Impaired motor coordination (decreased rotarod performance)	Rat	IRIS	Dec-05
Semi-Volatile Organic Compounds (SVOCs)									
Acenaphthene	6.00E-02	-	-	-	-	-	-	1	-
Benzo(a)anthracene	8.57E-04	-	-	-	-	-	-	6	-
Benzo(b)fluoranthene	8.57E-04	-	-	-	-	-	-	6	-
Benzo(k)fluoranthene	8.57E-04	-	-	-	-	-	-	6	-
Benzoic acid	4.00E+00	-	-	-	-	-	-	1	-
Chrysene	8.57E-04	-	-	-	-	-	-	6	-
Flouranthene	4.00E-02	-	-	-	-	-	-	1	-
Fluorene	4.00E-02	-	-	-	-	-	-	1	-
2-Methylnaphthalene	8.57E-04	-	-	-	-	-	-	6	-
Naphthalene	8.57E-04	0.003	Medium	1	3,000	Nasal effects	Mice	IRIS	Dec-05
N-Nitrosodiphenylamine	2.00E-02	-	-	-	-	-	-	1	-
Phenanthrene	8.57E-04	-	-	-	-	-	-	6	-
Phenol	3.00E-01	-	-	-	-	-	-	1	-
Pyrene	3.00E-02	-	-	-	-	-	-	1	-
Polychlorinated Biphenyls (PCBs)									
PCB	7.00E-05	-	-	-	-	-	-	1	-
Dioxins and Furans									
TCDD	-	-	-	-	-	-	-	4	-
Total Petroleum Hydrocarbons (TPH)									
TPH C6-C8	1.14E-01	4.00E-01	-	-	-	Hepatoxicity; Nephrotoxicit	-	TPHCWG, 7	1997
TPH C8-C10	1.14E-01	4.00E-01	-	-	-	Hepatoxicity; Nephrotoxicit	-	TPHCWG, 7	1997
TPH C10-C12	5.71E-02	2.00E-01	-	-	-	Decreased body weight	-	TPHCWG, 7	1997
TPH C12-C16	5.71E-02	2.00E-01	-	-	-	Decreased body weight	-	TPHCWG, 7	1997
TPH C16-C24	-	-	-	-	-	Nephrotoxicity	-	TPHCWG, 8	1997
TPH C24-C36	-	-	-	-	-	Nephrotoxicity	-	TPHCWG, 9	1997

Definitions:

DTSC - Department of Toxic Substances Control.
MF - Modifying factor.
mg/kg/day - Milligrams per kilogram per day.
mg/m3 - Milligrams per cubic meter.
PRG - Preliminary remediation goal table (Region 9 USEPA, 2004c)
RfC - Reference concentration.
RfD - Reference dose.
TCDD - 2,3,7,8-Tetrachlorodibenzo-p-dioxin and related compounds
UF - Uncertainty factor.

Notes:

RfCs are converted to RfDs for humans using the equation: (RfC/1)(20m3/day)(1/70kg).
1 - A route-to-route extrapolation was performed, the oral RfD was applied for the inhalation route of exposure.
2 - An inhalation RfC not recommended at this time (IRIS, 2005a)
3 - Lead assessed using Leadspread v7.0 (DTSC 2000b) and the USEPA (2003b) Adult Lead Model (ALM).
4 - No RfDs available from IRIS or HEAST.
5 - Isopropylbenzene used as a surrogate
6 - Napthalene used as a surrogate
7 - Aromatic inhalation RfC selected as more health protective.
8 - C16-C21 used as a surrogate
9 - C21-C35 used as a surrogate

Table B-3.5
Dermal Exposure Values
Georgia Pacific Corporation
Fort Bragg, California

Chemical	ABS[1]	Kp (cm/hr)	Notes
METALS			
Antimony	0.01	-	-
Arsenic	0.03	1.0E-03	2
Barium	0.01	1.0E-03	2
Beryllium	0.01	1.0E-03	2
Chromium	0.01	-	-
Cobalt	0.01	-	-
Copper	0.01	-	-
Lead	-	-	-
Mercury	0.01	-	-
Molybdenum	0.01	-	-
Nickel	0.01	-	-
Selenium	0.01	1.0E-03	2
Silver	0.01	-	-
Thallium	0.01	-	-
Vanadium	0.01	-	-
Zinc	0.01	6.0E-04	2
ORGANICS			
Volatile Organic Compounds (VOCs)			
Acetone	0.1	5.1E-04	3
Benzene	0.1	1.5E-02	2
2-Butanone	0.1	9.6E-04	2
n-Butylbenzene	0.1	3.4E-01	3
Carbon disulfide	0.1	1.8E-02	2
Chloroform	0.1	6.8E-03	2
1,1-Dichloroethane	0.1	6.7E-03	2
1,1-Dichloroethene	0.1	1.2E-02	2
cis-1,2-Dichloroethene	0.1	7.7E-03	2
trans-1,2-Dichloroethene	0.1	7.7E-03	2
Ethylbenzene	0.1	4.9E-02	2
Freon 113	0.1	6.7E-03	2
Isopropanol (Isopropyl alchohol, 2-propanol)	0.1	4.2E-04	4
Isopropylbenzene	0.1	8.6E-02	3
Methylene chloride	0.1	3.5E-03	2
Methyl-tert-butyl ether (MTBE)	0.1	2.1E-03	2
Naphthalene	0.15	4.7E-02	2
para-Isopropyl Toluene	0.1	7.1E-02	5
Propylbenzene	0.1	7.8E-02	3
sec-Butylbenzene	0.1	1.8E-01	3
Tetrachloroethene (PCE)	0.1	3.3E-02	2
Toluene	0.1	3.1E-02	2
Trichloroethene (TCE)	0.1	1.2E-02	2
1,1,1-Trichloroethane	0.1	1.3E-02	2
1,2,4-Trimethylbenzene	0.1	8.6E-02	2
1,3,5-Trimethylbenzene	0.1	6.2E-02	2
o-Xylene	0.1	5.3E-02	2
m,p-Xylenes	0.1	5.3E-02	2

Table B-3.5
Dermal Exposure Values
Georgia Pacific Corporation
Fort Bragg, California

Chemical	ABS[1]	Kp (cm/hr)	Notes
Semi-Volatile Organic Compounds (SVOCs)			
Acenaphthene	0.15	8.6E-02	3
Benzo(a)anthracene	0.15	4.7E-01	2
Benzo(b)fluoranthene	0.15	7.0E-01	2
Benzo(k)fluoranthene	0.15	2.1E+00	3
Benzoic Acid	0.1	5.7E-03	2
Chrysene	0.15	4.7E-01	2
Fluoranthene	0.13	2.2E-01	2
Fluorene	0.15	1.1E-01	2
2-Methylnaphthalene	0.15	1.3E-01	2
Naphthalene	0.15	4.7E-02	2
N-Nitrosodiphenylamine	0.1	1.0E-03	2
Phenanthrene	0.15	1.4E-01	2
Phenol	0.1	4.3E-03	2
Pyrene	0.15	1.7E-01	3
TPH			
TPH C6-C8	0.1	6.1E-02	6
TPH C8-C10	0.1	4.9E-02	6
TPH C10-C12	0.1	5.8E-02	6
TPH C12-C16	0.1	4.5E-02	6
TPH C16-C24	0.1	4.2E-02	6
TPH C24-C36	0.1	4.9E-02	6

Definitions:

- = constituent not defined as a volatile compound (as per USEPA 1996a)

Notes:

1 - absorption fraction for soil dermal absorption (DTSC 1999)
2 - RAGS Part E Supplemental Guidance for Dermal Risk Assessment (USEPA 2004a)
3 - Groundwater chemical desk reference (Montgomery 2000)
4 - Mackay 1995
5 - Isopropylbenzene used as a surrogate
6 - Calculated from K_{oc} (TPHCWG 1997, USEPA 1996b, 2002b).

Table B-3.6
Soil Risk-based Screening Criteria -- Human Health
Georgia Pacific Wood Products Facility
Fort Bragg, California

	Carcinogenic RBSC			Non-Carcinogenic RBSC		
Chemical	**Direct**	**Indoor air**	**Combined**	**Direct**	**Indoor air**	**Combined**
METALS						
Antimony	-	-	-	30	-	30
Arsenic	0.6	-	0.6	22	-	22
Barium	-	-	-	15,202	-	15,202
Beryllium	32,658	-	32,658	152	-	152
Cadmium	-	-	-	78	-	78
Chromium	-	-	-	>100,000	-	>100,000
Cobalt	27,992	-	27,992	1,459	-	1,459
Copper	-	-	-	3,040	-	3,040
Lead[1]	-	-	-	-	-	255
Mercury	-	-	-	23	-	23
Molybdenum	-	-	-	380	-	380
Nickel	>100,000	-	>100,000	1,520	-	1,520
Selenium	-	-	-	380	-	380
Silver	-	-	-	380	-	380
Thallium	-	-	-	6	-	6
Vanadium	-	-	-	532	-	532
Zinc	-	-	-	22,803	-	22,803
ORGANICS						
Volatile Organic Compounds (VOCs)						
Acetone	-	-	-	54,568	93	93
Benzene	48	0.002	0.002	243	0.04	0.04
2-Butanone	-	-	-	36,379	147	147
n-Butylbenzene	-	-	-	2,425	2	2
sec-Butylbenzene	-	-	-	2,425	869	640
Carbon disulfide	18,288	-	-	6,063	0.2	0.2
Chloroform	156	0.01	0.01	606	0.1	0.1
1,1-Dichloroethane	847	0.02	0.02	6,063	0.5	0.5
1,1-Dichloroethene	-	-	-	3,032	0.1	0.1
cis-1,2-Dichloroethene	-	-	-	606	0.05	0.05
trans-1,2-Dichloroethene	-	-	-	1,213	0.01	0.01
Ethylbenzene	-	-	-	6,063	7	7
Freon 113	-	-	-	-	-	-
Isopropanol (Isopropyl alcohol)	-	-	-	#N/A	-	-
Isopropylbenzene	-	-	-	6,063	0.1	0.1
para-Isopropyl Toluene	-	-	-	6,063	33	33
Methylene chloride	345	0.05	0.05	3,638	3	3
Methyl-tert-butyl ether (MTBE)	2,683	0.5	0.5	-	9	9
Propylbenzene	-	-	-	2,425	1	1
Tetrachloroethene (PCE)	9	0.01	0.01	606	0.04	0.04
Toluene	-	-	-	12,126	1	1
1,1,1-Trichloroethane	-	-	-	16,977	2	2
Trichloroethene (TCE)	371	0.004	0.004	18	0.01	0.01
1,2,4-Trimethylbenzene	-	-	-	3,032	0.2	0.2
1,3,5-Trimethylbenzene	-	-	-	3,032	0.2	0.2
m,p-Xylenes	-	-	-	12,126	1	1
o-Xylene	-	-	-	12,126	1	1
Semi-Volatile Organic Compounds (SVOCs)						
Acenaphthene	-	-	-	3,270	2,615	1,453
Benzo(a)anthracene	4	-	4	1,090	-	1,090
Benzo(b)fluoranthene	4	-	4	1,090	-	1,090
Benzo(k)fluoranthene	4	-	4	1,090	-	1,090
Benzoic Acid	-	-	-	>100,000	-	>100,000
Chrysene	36	-	36	1,090	-	1,090
Fluoranthene	-	-	-	2,272	-	2,272

Table B-3.6
Soil Risk-based Screening Criteria -- Human Health
Georgia Pacific Wood Products Facility
Fort Bragg, California

	Carcinogenic RBSC			Non-Carcinogenic RBSC		
Chemical	**Direct**	**Indoor air**	**Combined**	**Direct**	**Indoor air**	**Combined**
Fluorene	-	-	-	2,180	8,953	1,753
2-Methylnaphthalene	-	-	-	218	4	4
Naphthalene	-	1	1	1,090	2	2
N-Nitrosodiphenylamine	537	-	537	1,213	-	1,213
Phenanthrene	-	-	-	1,090	212	178
Phenol	-	-	-	18,189	-	18,189
Pyrene	-	-	-	1,635	-	1,635
Polychlorinated Biphenyls (PCBs)	1	-	1	4	-	4
Tetrachlorodibenzo-dioxins and -fura	0.00004	-	0.00004	-	-	-
Total Petroleum Hydrocarbons (TPH)						
TPH C6-C8	-	-	-	12,126	2	2
TPH C8-C10	-	-	-	2,425	11	11
TPH C10-C12	-	-	-	2,425	17	17
TPH C12-C16	-	-	-	2,425	114	109
TPH C16-C24	-	-	-	1,819	-	1,819
TPH C24-C36	-	-	-	1,819	-	1,819

Notes

all units are in milligrams per kilogram (mg/kg)

1- Leadspread v7.0

Table B-3.7
Risk-based Soil Criteria for Chemical Migration to Groundwater
Georgia Pacific Wood Products Facility
Fort Bragg, California

	Carcinogenic RBSC Evaluations		Non-carcinogenic RBSC Evaluations		
Chemical	**Carcinogenic Groundwater RBSC (ug/l)**	**Predicted Soil RBSC (mg/kg)**	**Non- Carcinogenic Groundwater RBSC (ug/l)**	**Predicted Soil RBSC (mg/kg)**	**Most Protective RBSC for Soil (mg/kg)**
Volatile Organic Compounds (VOCs)					
Acetone	-	-	8,715	3	3
Benzene	1	0.003	52	0.1	0.003
2-Butanone	-	-	10,345	4	4
n-Butylbenzene	-	-	299	10	10
sec-Butylbenzene	-	-	313	9	9
Carbon disulfide	-	-	1,227	3	3
Chloroform	7	0.01	75	0.1	0.01
1,1-Dichloroethane	25	0.04	943	1	0.04
1,1-Dichloroethene	-	-	404	1	1
cis-1,2-Dichloroethene	-	-	70	0.1	0.1
trans-1,2-Dichloroethene	-	-	136	0.3	0.3
Ethylbenzene	-	-	1,639	19	19
Fluorene	-	-	447	186	186
Freon 113	-	-	-	-	-
Isopropylbenzene	-	-	950	39	39
para-Isopropyl Toluene	-	-	957	145	145
Methylene chloride	24	0.02	1,678	1	0.02
Methyl-tert-butyl ether (MTBE)	131	0.1	8,050	0.1	0.1
Propylbenzene	-	-	330	6	6
Tetrachloroethene (PCE)	1	0.01	82	0.4	0.01
Toluene	-	-	1,015	6	6
1,1,1-Trichloroethane	-	-	3,920	16	16
Trichloroethene (TCE)	18	0.1	10	0.1	0.1
1,2,4-Trimethylbenzene	-	-	18	1	1
1,3,5-Trimethylbenzene	-	-	17	1	1
m,p-Xylenes	-	-	303	4	4
o-Xylene	-	-	259	3	3
Semi-Volatile Organic Compounds (SVOCs)					
Acenaphthene	-	-	572	122	122
2-Methylnaphthalene	-	-	9	1	1
Naphthalene	2	0.1	10	1	0.1
Phenanthrene	-	-	18	3	3
Total Petroleum Hydrocarbons (TPH)					
TPH C6-C8	-	-	932	29	29
TPH C8-C10	-	-	654	32	32
TPH C10-C12	-	-	439	33	33
TPH C12-C16	-	-	445	68	68
TPH C16-C24	-	-	1,029	493	493
TPH C24-C36	-	-	-	-	-

Table B-3.8
Risk-based Screening Criteria
for Potable Groundwater Use
Georgia Pacific Wood Products Facility
Fort Bragg, California

	RBSCs for Potable Water Use	
Chemical	**Carcinogenic**	**Non-carcinogenic**
METALS		
Arsenic	0.07	11
Barium	-	729
Beryllium	-	73
Nickel	-	730
Selenium	-	182
Zinc	-	10,940
ORGANICS		
Volatile Organic Compounds (VOCs)		
Acetone	-	8,715
Benzene	1.4	52
2-Butanone	-	10,345
n-Butylbenzene	-	299
sec-Butylbenzene	-	313
Carbon disulfide	-	1,227
Chloroform	7	75
1,1-Dichloroethane	25	943
1,1-Dichloroethene	-	404
cis-1,2-Dichloroethene	-	70
trans-1,2-Dichloroethene	-	136
Ethylbenzene	-	1,639
Freon 113	-	-
Isopropylbenzene	-	950
para-Isopropyl Toluene	-	957
Methylene chloride	24	1,678
Methyl-tert-butyl ether (MTBE	131	8,050
Propylbenzene	-	330
Tetrachloroethene (PCE)	1	82
Toluene	-	1,015
1,1,1-Trichloroethane	-	3,920
Trichloroethene (TCE)	18	10
1,2,4-Trimethylbenzene	-	18
1,3,5-Trimethylbenzene	-	17
m,p-Xylenes	-	303
o-Xylene	-	259
Semi-Volatile Organic Compounds (SVOCs)		
Benzoic Acid	-	144,770
Flouranthene	-	1,093
Naphthalene	2	10
Phenol	-	10,879
Total Petroleum Hydrocarbons (TPH)		
TPH C6-C8	-	932
TPH C8-C10	-	654
TPH C10-C12	-	439
TPH C12-C16	-	445
TPH C16-C24	-	1,029
TPH C24-C36	-	1,021

Definitions:
ug/L - micrograms per liter
RBSC - risk-based screening criteria

Notes:
All units are in ug/L

Table B-3.9
Risk-based Screening Criteria for Volatile Chemical
Migration from Groundwater to Indoor Air
Georgia Pacific Wood Products Facility
Fort Bragg, California

	Groundwater RBSCs Protective of Residential Exposures to Indoor Vapors (ug/L)	
Chemical	**Carcinogenic**	**Non-carcinogenic**
ORGANICS		
Volatile Organic Compounds (VOCs)		
Acetone	-	>100,000
Benzene	17	344
Carbon disulfide	-	1,176
Chloroform	114	503
1,1-Dichloroethane	332	6,158
1,1-Dichloroethene	-	434
cis-1,2-Dichloroethene	-	614
Freon 113	-	-
Methyl-tert-butyl ether (MTBE)	12,449	>100,000
n-Propylbenzene	-	1,461
Tetrachloroethene	33	161
1,1,1-Trichloroethane	-	9,065
Trichloroethene	152	247
Semi-Volatile Organic Compounds (SVOCs)		
Naphthalene	250	598
Total Petroleum Hydrocarbons (TPH)		
TPH C6-C8	-	706
TPH C8-C10	-	4,589
TPH C10-C12	-	7,392
TPH C12-C16	-	40,279

Table B.3-10

LEADSPREAD v7.0

CALIFORNIA DEPARTMENT OF TOXIC SUBSTANCES CONTROL (DTSC)

Residential Exposure Scenario
Draft Risk-based Screening Criteria for Soil
Fort Bragg, California

INPUT	
MEDIUM	LEVEL
Lead in Air (ug/m^3)	0.028
(ug/g)	1
Lead in Water (ug/l)	15
% Home-grown Produ	0%
(ug/m^3)	1.5

OUTPUT							
	Percentile Estimate of Blood Pb (ug/dl)					PRG-99	PRG-95
	50th	90th	95th	98th	99th	(ug/g)	(ug/g)
BLOOD Pb, ADULT	1.1	2.0	2.4	2.9	3.3	2,417	3,809
BLOOD Pb, CHILD	1.5	2.8	3.3	4.1	4.6	255	435
BLOOD Pb, PICA CHILD	1.6	2.8	3.4	4.1	4.6	128	219
BLOOD Pb, OCCUPATIO	1.1	2.0	2.4	2.9	3.3	3,475	5,464

EXPOSURE PARAMETERS			
	units	adults	children
Days per week	days/wk	7	
Days per week, occupational		5	
Geometric Standard Deviation		1.6	
Blood lead level of concern (ug		10	
Skin area, residential	cm^2	5,700	2,900
Skin area occupationa	cm^2	2,900	
Soil adherence	ug/cm^2	70	200
Dermal uptake consta	(ug/dl)/(ug	0.0001	
Soil ingestion	mg/day	50	100
Soil ingestion, pica	mg/day		200
Ingestion constant	(ug/dl)/(ug	0.04	0.16
Bioavailability	unitless	0.44	
Breathing rate	m^3/day	20	6.8
Inhalation constant	(ug/dl)/(ug	0.08	0.19
Water ingestion	l/day	1.4	0.4
Food ingestion	kg/day	1.9	1.1
Lead in market basket	ug/kg	3.1	
Lead in home-grown produ	ug/kg	0.5	

PATHWAYS						
ADULTS	Residential			Occupational		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	3.8E-5	0.00	0%	1.4E-5	0.00	0%
Soil Ingestion	8.8E-4	0.00	0%	6.3E-4	0.00	0%
Inhalation, bkgrnd		0.05	4%		0.03	3%
Inhalation	2.5E-6	0.00	0%	1.8E-6	0.00	0%
Water Ingestion		0.84	75%		0.84	76%
Food Ingestion, bkgrnd		0.23	21%		0.23	21%
Food Ingestion	0.0E+0	0.00	0%			0%

CHILDREN	typical			with pica		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	5.6E-5	0.00	0%		0.00	0%
Soil Ingestion	7.0E-3	0.01	0%	1.4E-2	0.01	1%
Inhalation	2.0E-6	0.00	0%		0.00	0%
Inhalation, bkgrnd		0.04	2%		0.04	2%
Water Ingestion		0.96	62%		0.96	62%
Food Ingestion, bkgrnd		0.54	35%		0.54	35%
Food Ingestion	0.0E+0	0.00	0%		0.00	0%

Table B-3.11
Ecological RBSCs
Georgia Pacific Wood Products Facility
Fort Bragg, California

Chemical	Herbivorous Deer Mouse SSL (mg/kg)		Insectivorous Deer Mouse SSL (mg/kg)		Plant SSL[3] (mg/kg)	Deer Mouse Vapor SL[4] (mg/m^3)	Deer Mouse Inhalation SSL (mg/kg)	Eco Screening Values (mg/kg)	
	Low[1]	High[2]	Low[1]	High[2]				Low	High
Antimony	0.782	16.1	0.169	3.48	5	N/A	N/A	0.17	3
Arsenic	37.7	554	18.5	582	10	N/A	N/A	10	554
Barium	338.8	1,245	519	1,907	500	N/A	N/A	339	1,245
Beryllium	134	670	61.9	309.3	10	N/A	N/A	10	309
Cadmium	0.57	25	0.017	1.98	4	N/A	N/A	0.02	2
Chromium, Total	325,177	1,625,886	8,767	43,836	5	N/A	N/A	5	43,836
Cobalt	183	3,046	51.5	858	38	N/A	N/A	38	858
Copper	33.4	7,813	32.8	157,785	93	N/A	N/A	33	7,813
Lead	93.7	18,918	11.72	7,515	50	N/A	N/A	12	7,515
Mercury	1.45	23.5	1.72	611	0.3	N/A	N/A	0.3	24
Molybdenum	5.06	50.6	1.41	14.1	2	N/A	N/A	1.4	14
Nickel	9.92	2,357	0.78	185	30	N/A	N/A	0.8	185
Selenium	5.77	140	0.173	12.9	1	N/A	N/A	0.2	13
Silver	4.63	23.2	0.942	4.71	2	N/A	N/A	0.9	5
Thallium	129.3	385	3.05	9.1	1	N/A	N/A	1	9
Vanadium	49.3	493	20.3	203	75	N/A	N/A	20	203
Zinc	33.7	1,925	0.21	26,098	50	N/A	N/A	0.2	1,925
1,1-Dichloroethane	No TRV		No TRV		No TRV	No TRV	-	-	-
1,2,4-Trimethylbenzene	17.04	85.3	0.521	2.61	No TRV	15.5	2.14	1	3
1,3,5-Trimethylbenzene	13.41	67.2	0.655	3.28	No TRV	15.5	0.354	0.4	3
2-Butanone (MEK)	44.4	78.2	10577	18645	No TRV	868.58	109	44	78
Acetone	0.0793	0.397	34.7	173.2	No TRV	1305	87.91	0.08	0.4
cis-1,2-Dichloroethene	83.72	838	28.6	286	No TRV	1.888	0.00491	0.005	286
Ethylbenzene	0.182	0.91	0.0086	0.043	200	23.232	0.237	0.009	0.04
Isopropylbenzene (cumene)	0.325	1.63	0.0093	0.0465	No TRV	23.232	0.1022	0.009	0.05
m,p-Xylenes	10.44	52.2	0.4	2	200	15.5	0.0853	0.09	2
Methyl tert-butyl ether (MTBE)	No TRV		No TRV		No TRV	47.7569588	0.313	0.31	-
Methylene Chloride	0.439	3.76	0.713	6.1	No TRV	0.87	0.00211	0.002	4
n-butylbenzene	0.733	3.67	0.00426	0.0213	No TRV	23.232	1.064	0.004	0.02
o-Xylene	9.528	47.8	0.591	2.96	200	15.5	0.0942	0.09	3
p-cymene (p-isopropyltoluene)	89.6	449	89.6	448	No TRV	15.5	1.764	1.8	448
sec-butylbenzene	0.628	3.14	0.00494	0.0247	No TRV	23.232	0.569	0.005	0.02
Toluene	0.1124	0.562	0.0156	0.078	200	0.0839	0.00053	0.001	0.08
trans-1,2-Dichloroethene	83.72	838	28.6	286	No TRV	1.888	0.00302	0.003	286
n-Nitrosodiphenylamine	No TRV		No TRV		No TRV	No TRV		-	-
Benzene	0.15	0.748	0.0724	0.362	200	0.5714	0.00162	0.002	0.4
Tetrachloroethene	0.719	3.6	0.0187	0.0934	No TRV	24.25	0.05	0.02	0.09

Table B-3.11
Ecological RBSCs
Georgia Pacific Wood Products Facility
Fort Bragg, California

Chemical	Herbivorous Deer Mouse SSL (mg/kg) Low[1]	High[2]	Insectivorous Deer Mouse SSL (mg/kg) Low[1]	High[2]	Plant SSL[3] (mg/kg)	Deer Mouse Vapor SL[4] (mg/m^3)	Deer Mouse Inhalation SSL (mg/kg)	Eco Screening Values (mg/kg) Low	High
Trichloroethene	0.32	1.6	0.0865	0.432	No TRV	6.429	0.0244	0.02	0.4
1,1,1-Trichloroethane	320.7	1604	97.7	488.5	No TRV	38.2	0.0629	0.1	489
2-Methylnaphthalene	3,926	14,245	5.94	17.8	46	0.375	2.12	2	18
Acenaphthene	6,491	14,620	11.9	23.73	20	N/A	N/A	12	24
Benzo(a)anthracene	12.38	310	0.2	5.01	46	N/A	N/A	0.2	5
Benzo(b)fluoranthene	35.71	894	0.095	2.37	46	N/A	N/A	0.1	2
Benzo(k)fluoranthene	25.07	628	0.097	2.42	46	N/A	N/A	0.1	2
Chrysene	8.57	215	0.112	2.8	46	N/A	N/A	0.11	3
Fluorene	5386	10,772	6.49	13	76	0.169	6.38	6	13
Naphthalene	278.3	834	5.94	17.8	46	0.375	0.197	0.2	18
Phenanthrene	51.11	85.2	4.34	7.22	46	0.169	4.8	4	7
Pyrene	105.3	176	3.9	6.5	56	N/A	N/A	4	7
Total PCBs	6.72	24.1	0.556	1.42	No TRV	N/A	N/A	0.6	1.4
TCDD-equivalent	0.00012	0.0012	0.0000052	0.000037	No TRV	N/A	N/A	0.000005	0.00004
TCDF Total	0.0002	0.002	0.000014	0.00010	No TRV	N/A	N/A	0.00001	0.0001

1 The low SSL is based on a NOAEL-equivalent TRV-Low, either the lowest NOAEL available (Navy-BTAG) or an appropriate selected NOAEL (non Navy BTAG).
2 The high SSL is based on a LOAEL-equivalent TRV-High, either a LOAEL corresponding to the midpoint of LOAEL TRV values (Navy-BTAG), or an appripriate selected LOAEL (non-Navy-BTAG).
3 The Plant SSL is the soil-to-plant TRV.
4 The inhalation screening level is the mammal inhalation TRV adjusted by the deer mouse body weight. This assumes a 24 hour/day, 7 day/week exposure.

APPENDIX C

BACKGROUND DETERMINATION

APPENDIX C

BACKGROUND DETERMINATION

Background can be defined as the concentrations of constituents in a medium, such as soil, that are naturally occurring from undisturbed geologic sources or that occur solely from a source other than man's activities at the Site. Background should be established based on the local geographical area and should include available information to select a representative samples outside of the area impacted by Site activities. The background sampling locations should consider the natural variability of constituents in a medium and processes such as erosion, weathering, and dissolution of mineral deposits that could cause variability. Determination of appropriate background concentrations for metals is required to allow identification of contaminated areas (DTSC 1997).

Three lines of evidence will be used to determine background concentrations of metals. In accordance with DTSC (1997) guidance, these lines of evidence include (1) local background samples collected from areas unimpacted by past Site uses, (2) use of ambient concentrations, and (3) California background concentrations (Bradford et al. 1996). The combination of all three lines of evidence will be used.

One line of evidence that will be used to determine background metals concentrations will be direct sampling of local unimpacted soils. A supplemental investigation has been proposed to identify and sample locations that can be used to determine local background metal concentrations. The background locations are being selected by review of available surficial geology and soil type maps, maps and other information on historical site operations, and the results of the Site investigations. In addition, potential locations will be inspected for their suitability. Surficial geology maps are being reviewed to ensure the geologic formation of the background area is the same as the formation of the areas of potential impact. Soil type maps are being used to try to identify areas with similar soil formations to account for potential changes to soil chemistry caused by the formation of soils. A review data on historical site operations and of investigation results is also being conducted to ensure background sampling locations are outside of areas impacted by past Site operations. This review will include an inspection of historical aerial photographs. On the basis of these reviews, background sample locations will be proposed for various locations to attempt to provide the range of concentrations to assess the natural heterogeneity of the surface and subsurface soils in the vicinity of the Site.

Each proposed location will be inspected for suitability for background sampling. The inspections will include an evaluation of the following criteria: (1) absence of evident impacts from of past Site operations, including waste disposal and grading, (2) location away from probable migration of metals from nearby areas potentially impacted by past Site operations (e.g. runoff, wind), (3) comparability of the soil profiles to other areas of the Site, (4) type of plant cover (i.e. whether more akin to native cover or to recently disturbed areas, and (5) accessibility.

To ensure comparability, soil samples will be analyzed using the same methods as used in the Site investigations. The sampling results will be examined graphically and statistically to determine the range, variability, and distributions of metal concentrations. Factors, such as depth, soil type, and other field observations, will be examined to determine whether metal concentrations can be considered representative of background conditions. Also, as part of this analysis, the data will be evaluated statistically to assess whether concentrations differ depending on depth. Statistical analyses, such as the Wilcoxon Rank Sum test (DTSC 1997) and the paired t-test (Sokal and Rohlf 1981), will be used for this evaluation. Depending on the results of these analyses, a recommendation will be made as to whether the data for all depths can be pooled or whether the depth intervals should be considered separately.

The second line of evidence that will be used to define background is based on DTSC (1997) guidance, which states that the best description of ambient metal concentrations is obtained from the largest data set possible. For this reason, DTSC (1997) guidance indicates that the ambient background dataset can be expanded using investigation results from the same Site, assuming soil types and analytical methods are generally similar. This approach assumes that while a sample may be contaminated relative to one or a few metals, it might display ambient concentrations of other metals (DTSC 1997). Accordingly, DTSC (1997) guidance presents a methodology for identifying the ambient data. This methodology consists of an examination of the summary statistics and data distributions, as well as graphical analyses using cumulative probability analysis. These analyses are intended to identify separate statistical populations present in the sample data set for each metal and to identify those samples that are clearly elevated relative to background.

The potential for applying this methodology to this Site was preliminarily examined using data collected previously (TRC 2004b,c) for six metals (arsenic, cadmium, cobalt, copper, nickel, and zinc). Initially, cumulative probability plot analyses of metals data from the TRC (2004b,c) study (188 samples) were developed. The plots, as shown for arsenic in Figure 1, suggested that there may be two populations of metal concentrations observable in the data, with a limited number of the samples (approximately 5 to 10 per metal) potentially impacted. As can be observed in Figure 1, the arsenic plot has a breakpoint at 8 mg/kg. Samples with arsenic concentrations greater than 8 mg/kg are potentially impacted and were excluded from further analysis. The remaining data set consists of 172 samples that fit a normal distribution with a mean of 4.3 mg/kg, a concentration range of 0.71 to 7.7 mg/kg, and a coefficient of variation of 0.35. These data meet the expectations for an ambient data set in that the range of detected values is less than two orders of magnitude, and the coefficient of variation (CV) is less than 1 (DTSC 1997). The 95th percentile of the arsenic data is 6.8 mg/kg, the 99th percentile is 7.5 mg/kg, and the 95th upper tolerance limit (UTL_{95}) is 7.1 mg/kg.

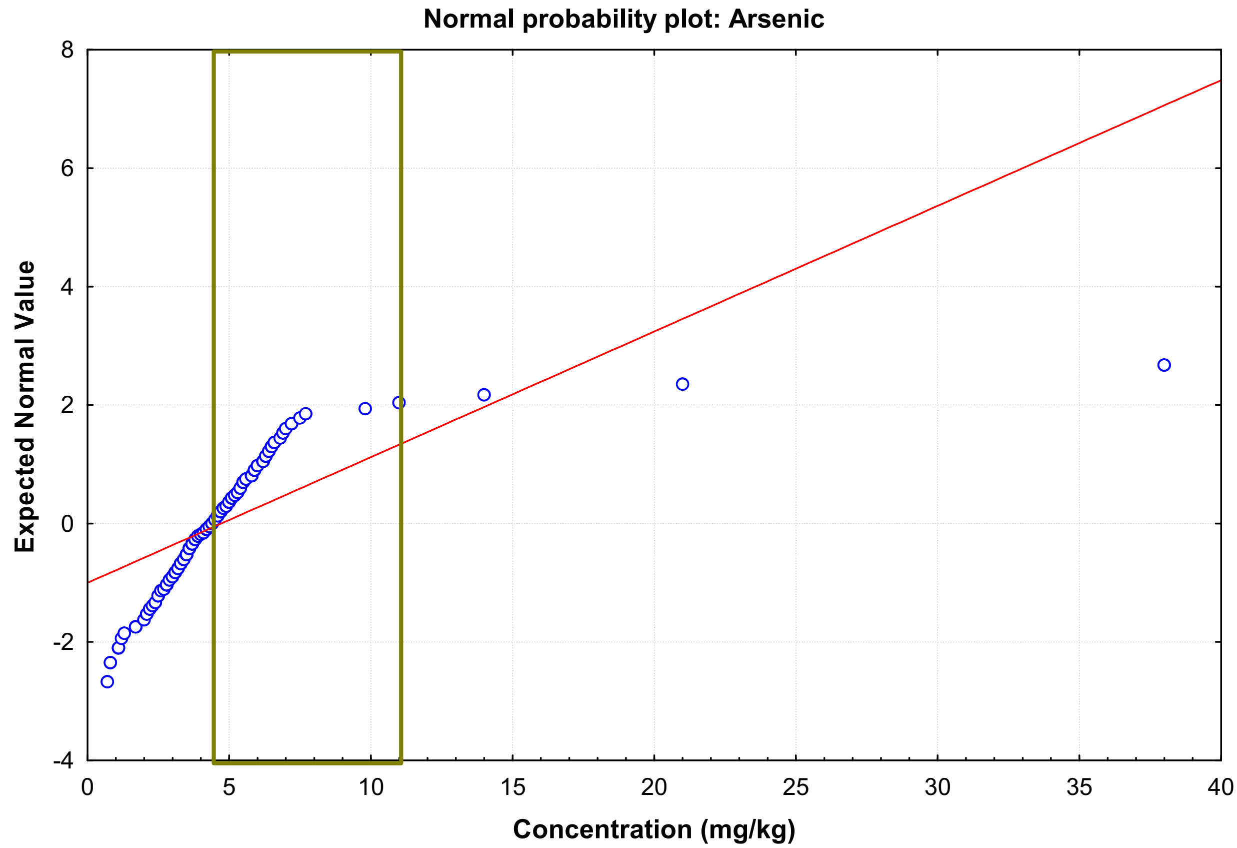

Figure 1. Cumulative probability plot for arsenic in soils, based on TRC (2004 b,c) data. The green box indicates the 75th percentile and maximum California background concentrations reported in Bradford et al (1996).

Summary statistics and estimates of the UTL_{95} for each of the six metals that were evaluated (excluding obvious outliers) are provided in Table 1. All of these metals appear to meet the requirements outlined by DTSC (1997) for inclusion in an ambient background data set.

Table 1
Summary Statistics* for Preliminary Background Metals Determination

		Concentration (mg/kg)						
Metal	N	Mean	CV	Minimum	Maximum	95th percentile	99th percentile	UTL_{95}
Arsenic	172	4.3	0.35	0.71	7.7	6.8	7.5	7.07
Cadmium	156	1.6	0.46	0.29	3.3	2.8	3.1	2.93
Cobalt	170	6.3	0.55	1.1	15	13	15	12.85
Copper	161	13.9	0.69	0.89	38	33	36	31.90
Nickel	176	21.5	0.43	1.5	47	39	45	38.52
Zinc	172	40.6	0.54	3.1	120	80	110	81.70

* excluding obvious outliers

Based on these preliminary analyses it appears reasonable to expand the background dataset using ambient data collected at the Site. Thus, all metals will be reanalyzed to determine background concentrations using these techniques in support of the HHERA, using a combination of the data from the TRC (2004b,c) and the ongoing AME investigations.

To further ensure that use of an expanded dataset is reasonable, the local background datasets for each metal will also be compared to the ambient data set using both graphical (histograms and cumulative probability plots) and statistical (Wilcoxon Rank Sum test) tests as recommended by DTSC (1997). If the onsite background and ambient data sets agree, the data will be combined and a single estimate of the background concentrations will be derived. If the onsite background data and ambient data do not agree, three approaches may be utilized. First, the ambient data set may be re-evaluated to determine if additional samples should be eliminated as potentially contaminated. Secondly, the results from the local background sampling alone may be used to determine appropriate background concentrations. Thirdly, additional background locations may be sampled to supplement the local background sampling data set and provide a better estimate of background concentrations.

Finally, as a third line of evidence, the background dataset developed for this Site will be compared to the range of values typically present in California soils. Bradford et al. (1996) collected soil samples from 75 unimpacted soils throughout the state of California, and determined the concentrations of over 17 metals in each sample. Statistics tabulated by Bradford et al. (1996) include the 75th percentile and the maximum of the sampling distribution. Summary data are provided in Table 2 for the metals that have been detected in soils at the Site. The 75th percentile and maximum concentration will be used to define potential upperbound of background concentrations and compared to the ambient and local background data sets.

Table 2
Background Metals Concentrations (mg/kg) in California Soils
(Bradford et al. 1996)

Metal	Minimum	50th percentile	75th percentile	Maximum
Antimony	0.15	0.47	0.73	1.95
Arsenic	0.6	2.7	4.7	11
Barium	133	519.5	625	1,400
Beryllium	0.25	1.265	1.53	2.7
Cadmium	0.05	0.275	0.44	1.7
Chromium	23	69	115	1,579
Cobalt	2.7	11.6	18.3	46.9
Copper	9.1	21.6	36.6	96.4
Lead	12.4	20.6	26.7	97.1
Mercury	0.05	0.19	0.34	0.9
Molybdenum	0.1	0.85	1.4	9.6
Nickel	9	27	56	509
Selenium	0.015	0.015	0.05	0.43
Silver	0.1	0.37	0.53	8.3
Thallium	0.17	0.54	0.69	1.1
Vanadium	39	94	134	288
Zinc	88	153	170	236

APPENDIX D

POTENTIALLY OCCURRING PLANT AND ANIMAL SPECIES

Appendix D-1
List of Plant Species Observed at the Georgia-Pacific Fort Bragg Facility[1]

Scientific Name	Common Name	CNPS List[2]
Acaena pinnatifida var. californica	acaena	
Achillea millefolium	yarrow	
Agrostis blasdealei	Blasdale's bent grass	1B
Alisma plantago-aquatica	water plantain	
Allium triqutrum	ornamental onion	
Aira caryophyllea	silver hairgrass	
Aira praecox	yellow hair grass	
Alnus rubra	red alder	
Ambrosia chamissonis	beach bur	
Anagallis arvensis	scarlet pimpernel	
Angelica hendersonii	angelica	
Anthoxanthum odoratum	sweet vernal grass	
Armeria maritima ssp californica	sea pink	
Athyrium filix-femina	lady fern	
Avena barbata	slender wild oat	
Azolla sp.	mosquito fern	
Baccharis pilularis	coyote brush	
Baccharis salicifolia	mulefat	
Bellardia trixago	Mediterranean lineseed	
Brassica nigra	black mustard	
Briza maxima	quaking grass	
Briza minor	little quaking grass	
Brodiaea coronaria	harvest brodiaea	
Bromus carinatus var. maritimus	California brome	
Bromus diandrus	ripgut brome	
Bromus hordeaceus	soft chess	
Bromus sterilus	brome	
Calandria ciliata	red maids	
Camissonia cherianthifolia	dune primrose	
Carduus pycnocephalus	Italian thistle	
Carex obnupta	slough sedge	
Carex feta	feta sedge	
Carex deweyana ssp. deweyana	shorter scaled sedge	
Carpobrotus chiliensis	ice plant	
Carpobrotus edulis	ice plant	
Castelleja mendocinensis	Mendocino coast Indian paintbrush	1B
Chyrsanthemum leucanthemum	corn cyrsanthemum	
Cirsium vulgare	bull thistle	
Clarkia davyi	Davy's clarkia	
Claytonia perfoliata	miner's lettuce	
Conium maculatum	poison hemlock	
Corylus cornuta	California hazelnut	
Cotula coronopifolia	brass buttons	
Conyza canadensis	horseweed	
Cotoneaster panosa	cotoneaster	
Cynodon dactylon	bermuda grass	
Cynosurus echinatus	dogtail	
Cyperus eragrositis	tall flatsedge	
Cyperus niger	black cyperus	
Cystisus scoparius	Scotch broom	
Dactylis glomerata	orchard-grass	

Appendix D-1
List of Plant Species Observed at the Georgia-Pacific Fort Bragg Facility[1]

Scientific Name	Common Name	CNPS List[2]
Danthonia californica	California oatgrass	
Daucus pusillus	rattlesnake weed	
Deliera odorata	Cape ivy	
Deschampsia cespitosa ssp. holciformis	tufted hairgrass	
Dudleya farinosa	stonecrop	
Elymus glaucus	blue wildrye	
Epilobium ciliatum	fringed willowherb	
Equisetum telmateia ssp. braunii	giant horsetail	
Equisetum arvense	common horsetail	
Erechtites glomerata	New Zealand fireweed	
Erechitites glomerata	Australian fireweed	
Erigeron glaucus	seaside daisy	
Eriogonum latifolium	dune buckwheat	
Erodium cicutarium	redstem filaree	
Erodium sp	filaree	
Erysimum menziesii ssp. concinnum	wallflower	
Escalonia sp.	escalonia	
Eschscholzia californica	California poppy	
Eucalyptus globulus	blue gum	
Festuca arundinacea	tall fescue	
Festuca rubra	red fescue	
Ficus sp.	ficus	
Fushia sp.	fushia	
Fragaria chiloensis	beach strawberry	
Galium aparine	common bedstraw	
Gaultheria shallon	salal	
Geranium carolinianum	Carolina geranium	
Geranium molle	dove’s foot geranium	
Gnaphalium palustre	western marsh cudweed	
Gnaphalium luteo-album	everlasting cudweed	
Gnaphalium sp.	cudweed	
Grindelia stricta var. platyphylla	gumplant	
Hedera helix	English ivy	
Heracleum lanatum	cow parsnip	
Hesperevax sparsiflora var. brevifolia	short leaved evax	2
Heterotheca sessiliflora	goldenaster	
Hirschfeldia incana	Mediterranean hoary mustard	
Holcus lanatus	purple velevetgrass	
Hordeum brachyantherum	meadow barley	
Hordeum marinum	Mediterranean barley	
Hordeum murinum	foxtail barley	
Hypochaeris radicata	rough cats ear	
Hydrocotyle sp.	hydrocotyle	
Iris douglasiana	Douglas iris	
Juncus bolanderi	Bolander’s rush	
Juncus bufonius	toad rush	
Juncus effusus	soft rush	
Juncus falcatus	falcate rush	
Juncus patens	spreading rush	
Juncus phaeocephalus	brown headed rush	
Lasthenia californica	California goldfields	

Appendix D-1
List of Plant Species Observed at the Georgia-Pacific Fort Bragg Facility[1]

Scientific Name	Common Name	CNPS List[2]
Leontodon taraxacoides	hawkbit	
Lemna sp.	duckweed	
Leymus mollis ssp. mollis	California beach grass	
Leymus triticoides	creeping wild-rye	
Lessingia filaginifolia	common California aster	
Lolium multiflorum	Italian ryegrass	
Lonicera involucrata	twinberry	
Lotus corniculatus	bird's foot trefoil	
Lotus humistratus	short podded lotus	
Lotus spp.	lotus	
Lythrum hyssopifolia	hyssop loosestrife	
Lupinus littoralis	bluff lupine	
Lupinus arboreus	yellow bush lupine	
Lupinus rivularis	river lupine	
Lysichiton americanum	yellow skunk cabbage	
Marah oreganus	wild cucumber	
Medicago polymorpha	California burclover	
Melilotus indica	yellow sweetclover	
Microseris borealis	northern microseris	
Mimulus guttatus	seep monkey flower	
Myrica californica	wax myrtle	
Myriophyllum aquaticum	parrot's feather	
Nemophila menziesii	baby blue eyes	
Oenanthe sarmentosa	water parsley	
Oxalis pes-caprae	Bermuda buttercup	
Oxalis sp.	oxalis	
Parentucellia viscosa	yellow parentucella	
Phacelia californica	rock phacelia	
Plantago coronopus	cut leaf plantain	
Plantago erecta	dwarf plantian	
Plantago lanceolata	English plantain	
Plantago major	common plantain	
Plantago maritima	coast plantain	
Platystemon californicus	cream cups	
Potentilla anserina ssp. pacifica	silverweed	
Pinus contorta ssp. contorta	shore pine	
Pinus radiata	Monterey pine	
Poa douglasii	dune bluegrass	
Poa unilateralis	blue bluff grass	
Polycarpon depressum	California allseed	
Polygonum paronychia	dune knotweed	
Polypodium sp.	polypody fern	
Polystichum munitum	sword fern	
Pteridium aquilinum var. pubescens	bracken fern	
Pyracantha angustifolia	firethorn	
Ranunculus californicus	California buttercup	
Raphanus sativa	wild radish	
Rubus discolor	Himilayan blackberry	
Rubus parviflorus	thimbleberry	
Rubus ursinus	California blackberry	
Rumex acetosella	sheep sorrel	

Appendix D-1
List of Plant Species Observed at the Georgia-Pacific Fort Bragg Facility[1]

Scientific Name	Common Name	CNPS List[2]
Rumex crispus	curly dock	
Rumex conglomeratus	clustered dock	
Rumex salicifolius var. crassus	dune dock	
Rorippa nasturtium-aquaticum	water cress	
Sagina maxima ssp. crassicaulis	pearlwort	
Salix hookeriana	coastal willow	
Salix laevigata	arroyo willow	
Sambucus racemosa	red elderberry	
Sanicula arctopoides	footsteps of spring	
Scirpus cernuus	tufted sedge	
Scirpus pungens	three-square	
Scirpus microcarpus	panicled rush	
Scrophularia californica	California figwort	
Sequoia sempervirens	coast redwood	
Senecio jacobaea	tansy ragwort	
Senecio vulgaris	groundsel	
Sherardia arvensis	blue fieldmadder	
Sidalcea malviflora	checker mallow	
Silybum marianum	milkweed	
Sisyrinchium californicum	California golden eyed grass	
Smilacena stellata	false Solomon’s seal	
Solanum sp.	nightshade	
Soliva sessilis	field burweed	
Sochus asper ssp. asper	prickly sow thistle	
Sonchus oleraceus	common sow thistle	
Stachys ajugoides var. rigida	hedge nettle	
Stachys chamissonis	coast hedge nettle	
Stellaria media	common chickweed	
Toxicodendron diversilobum	poison oak	
Triphysaria pusilla	triphysaria	
Trifolium depauperatum	pale sack clover	
Trifolium dubium	yellow clover	
Trifolium hirtum	strawberry clover	
Trifolium macrae	Chilean clover	
Trifolium microcephalum	maiden clover	
Trifolium repens	white clover	
Trifolium subterraneum	subterranean clover	
Trifolium variegatum	white tipped clover	
Triflolium willdenovii	tomcat clover	
Trifolium wormskioldii	cow clover	
Typha latifolia	cattail	
Vicia sativa	spring vetch	
Vicia sp.	vetch	
Vinca major	great periwinkle	
Vulpia myuros var. hirsuta	foxtail fescue	
Woodwardia fimbriata	giant chain fern	

Notes:

[1] from WRA (2005a) Biological Assessment

[2] California Native Plant Society listing status:
1B: Endangered, Threatened, or Rare in California

Scientific Name	Common Name	CNPS List[2]

2: Rare, threatened, or endangered in California, but more common elsewhere

Appendix D-2
List of Potential Vertebrate Species in Identified Habitats at the Georgia-Pacific Fort Bragg Facility

		Habitat usage			
CWHRS ID	Species Name	Freshwater Emergent Wetland	Annual Grassland	Marine (coastal)	Observed
Amphibians					
A001	CALIFORNIA TIGER SALAMANDER	Yearlong	Yearlong		
A002	NORTHWESTERN SALAMANDER	Yearlong			
A004	CALIFORNIA GIANT SALAMANDER	Yearlong			
A006	ROUGH-SKINNED NEWT	Yearlong	Yearlong		
A007	CALIFORNIA NEWT	Yearlong	Yearlong		
A014	CALIFORNIA SLENDER SALAMANDER		Yearlong		
A020	BLACK SALAMANDER		Yearlong		
A032	WESTERN TOAD	Yearlong	Yearlong		
A039	PACIFIC CHORUS FROG	Yearlong	Yearlong		
A040	RED-LEGGED FROG[1]	Yearlong	Yearlong		
A043	FOOTHILL YELLOW-LEGGED FROG		Yearlong		
A046	BULLFROG	Yearlong	Yearlong		X
A047	TIGER SALAMANDER	Yearlong	Yearlong		
A048	PACIFIC GIANT SALAMANDER	Yearlong			
Reptiles					
R004	WESTERN POND TURTLE	Yearlong	Summer		
R022	WESTERN FENCE LIZARD		Yearlong		X
R036	WESTERN SKINK		Yearlong		
R039	WESTERN WHIPTAIL		Yearlong		
R040	SOUTHERN ALLIGATOR LIZARD		Yearlong		
R042	NORTHERN ALLIGATOR LIZARD		Yearlong		
R048	RINGNECK SNAKE	Yearlong	Yearlong		
R051	RACER	Yearlong	Yearlong		
R057	GOPHER SNAKE	Yearlong	Yearlong		
R058	COMMON KINGSNAKE	Yearlong	Yearlong		
R059	CALIFORNIA MOUNTAIN KINGSNAKE		Yearlong		
R060	LONG-NOSED SNAKE		Yearlong		
R061	COMMON GARTER SNAKE	Yearlong	Yearlong		
R062	WESTERN TERRESTRIAL GARTER SNAKE	Yearlong	Yearlong		
R064	NORTHWESTERN GARTER SNAKE	Yearlong			
R071	NIGHT SNAKE		Yearlong		
R076	WESTERN RATTLESNAKE	Yearlong	Yearlong		
R078	PACIFIC COAST AQUATIC GARTER SNAKE	Yearlong	Yearlong		X
Birds					
B002	PACIFIC LOON			Winter	
B003	COMMON LOON			Winter	
B006	PIED-BILLED GREBE	Yearlong			
B009	EARED GREBE	Winter			
B010	WESTERN GREBE	Yearlong		Yearlong	
B043	BROWN PELICAN		Summer	Yearlong	
B044	DOUBLE-CRESTED CORMORANT	Yearlong		Yearlong	
B046	BRANDT'S CORMORANT			Yearlong	
B047	PELAGIC CORMORANT			Yearlong	X
B049	AMERICAN BITTERN	Yearlong			
B051	GREAT BLUE HERON	Yearlong	Yearlong	Yearlong	X
B052	GREAT EGRET	Yearlong	Yearlong		
B053	SNOWY EGRET	Yearlong			
B057	CATTLE EGRET	Winter	Winter		
B058	GREEN HERON	Yearlong			
B059	BLACK-CROWNED NIGHT HERON	Yearlong			

Appendix D-2
List of Potential Vertebrate Species in Identified Habitats at the Georgia-Pacific Fort Bragg Facility

		Habitat usage			
CWHRS ID	Species Name	Freshwater Emergent Wetland	Annual Grassland	Marine (coastal)	Observed
B062	WHITE-FACED IBIS	Yearlong	Yearlong		
B067	TUNDRA SWAN	Winter	Winter		
B070	GREATER WHITE-FRONTED GOOSE	Winter	Winter		
B071	SNOW GOOSE	Winter	Winter		
B072	ROSS' GOOSE	Winter	Winter		
B074	BRANT	Winter	Winter	Winter	
B075	CANADA GOOSE	Yearlong	Yearlong		X
B076	WOOD DUCK	Yearlong			
B077	GREEN-WINGED TEAL	Winter	Winter		
B079	MALLARD	Yearlong	Yearlong		X
B080	NORTHERN PINTAIL	Winter	Winter		
B082	BLUE-WINGED TEAL	Winter	Winter		
B083	CINNAMON TEAL	Yearlong	Summer		
B084	NORTHERN SHOVELER	Winter	Winter		
B085	GADWALL	Winter	Winter		
B086	EURASIAN WIGEON	Winter	Winter		
B087	AMERICAN WIGEON	Winter	Winter		
B089	CANVASBACK	Winter		Winter	
B090	REDHEAD	Winter		Winter	
B091	RING-NECKED DUCK	Winter			
B093	GREATER SCAUP			Winter	
B094	LESSER SCAUP	Winter	Winter	Winter	
B096	HARLEQUIN DUCK			Winter	
B097	OLDSQUAW			Winter	
B098	BLACK SCOTER			Winter	
B099	SURF SCOTER			Yearlong	
B100	WHITE-WINGED SCOTER			Winter	
B101	COMMON GOLDENEYE			Winter	
B102	BARROW'S GOLDENEYE			Winter	
B103	BUFFLEHEAD	Winter			
B104	HOODED MERGANSER	Winter			
B105	COMMON MERGANSER	Yearlong			
B106	RED-BREASTED MERGANSER			Winter	
B107	RUDDY DUCK	Yearlong		Yearlong	
B108	TURKEY VULTURE		Yearlong	Yearlong	X
B110	OSPREY	Yearlong	Summer	Summer	X
B111	WHITE-TAILED KITE	Yearlong	Yearlong		
B113	BALD EAGLE	Yearlong	Yearlong	Yearlong	
B114	NORTHERN HARRIER	Yearlong	Yearlong	Yearlong	
B115	SHARP-SHINNED HAWK		Yearlong		
B116	COOPER'S HAWK		Yearlong		
B119	RED-SHOULDERED HAWK	Yearlong	Yearlong		
B121	SWAINSON'S HAWK		Summer		
B123	RED-TAILED HAWK	Yearlong	Yearlong		
B124	FERRUGINOUS HAWK	Winter	Winter		
B125	ROUGH-LEGGED HAWK	Winter	Winter		
B126	GOLDEN EAGLE	Yearlong	Yearlong		
B127	AMERICAN KESTREL	Yearlong	Yearlong		
B128	MERLIN	Winter	Winter	Winter	
B129	PEREGRINE FALCON	Yearlong	Yearlong	Yearlong	
B131	PRAIRIE FALCON	Yearlong	Yearlong		
B133	RING-NECKED PHEASANT	Yearlong	Yearlong		
B134	BLUE GROUSE		Yearlong		
B138	WILD TURKEY		Yearlong		

Appendix D-2
List of Potential Vertebrate Species in Identified Habitats at the Georgia-Pacific Fort Bragg Facility

		Habitat usage			
CWHRS ID	Species Name	Freshwater Emergent Wetland	Annual Grassland	Marine (coastal)	Observed
B140	CALIFORNIA QUAIL		Yearlong		X
B141	MOUNTAIN QUAIL		Yearlong		
B143	BLACK RAIL	Yearlong			
B144	CLAPPER RAIL	Yearlong			
B145	VIRGINIA RAIL	Yearlong			
B146	SORA	Winter			
B148	COMMON MOORHEN	Yearlong			
B149	AMERICAN COOT	Yearlong	Winter		
B150	SANDHILL CRANE	Winter	Winter		
B151	BLACK-BELLIED PLOVER	Winter	Winter	Winter	
B154	SNOWY PLOVER			Yearlong	
B156	SEMIPALMATED PLOVER	Winter	Winter	Yearlong	
B158	KILLDEER	Yearlong	Yearlong	Yearlong	X
B159	MOUNTAIN PLOVER		Winter		
B162	BLACK OYSTERCATCHER			Yearlong	X
B163	BLACK-NECKED STILT	Yearlong			
B164	AMERICAN AVOCET	Yearlong		Yearlong	
B165	GREATER YELLOWLEGS	Winter		Winter	
B166	LESSER YELLOWLEGS	Migrant		Winter	
B168	WILLET	Summer	Winter	Yearlong	
B169	WANDERING TATTLER			Winter	
B170	SPOTTED SANDPIPER	Summer	Summer		
B172	WHIMBREL	Winter	Winter	Yearlong	
B173	LONG-BILLED CURLEW	Winter	Winter	Winter	
B176	MARBLED GODWIT	Winter	Winter	Winter	
B177	RUDDY TURNSTONE			Winter	
B178	BLACK TURNSTONE			Winter	
B179	SURFBIRD			Winter	
B180	RED KNOT			Summer	
B181	SANDERLING			Winter	
B183	WESTERN SANDPIPER	Winter		Winter	
B185	LEAST SANDPIPER	Winter		Winter	
B190	ROCK SANDPIPER			Winter	
B191	DUNLIN	Winter		Winter	
B196	SHORT-BILLED DOWITCHER	Winter			
B197	LONG-BILLED DOWITCHER	Winter			
B199	COMMON SNIPE	Winter			
B200	WILSON'S PHALAROPE	Summer	Migrant		
B211	BONAPARTE'S GULL	Winter		Winter	
B212	HEERMANN'S GULL			Summer	
B213	MEW GULL			Winter	
B214	RING-BILLED GULL	Yearlong	Yearlong	Yearlong	
B215	CALIFORNIA GULL	Yearlong	Yearlong	Yearlong	
B216	HERRING GULL			Winter	
B217	THAYER'S GULL			Winter	
B220	WESTERN GULL			Yearlong	X
B221	GLAUCOUS-WINGED GULL			Winter	
B227	CASPIAN TERN	Migrant		Migrant	X
B229	ELEGANT TERN			Summer	
B231	COMMON TERN	Winter		Winter	
B233	FORSTER'S TERN	Summer		Yearlong	
B234	LEAST TERN			Summer	
B235	BLACK TERN	Summer		Summer	
B237	COMMON MURRE			Yearlong	

Appendix D-2
List of Potential Vertebrate Species in Identified Habitats at the Georgia-Pacific Fort Bragg Facility

		Habitat usage			
CWHRS ID	Species Name	Freshwater Emergent Wetland	Annual Grassland	Marine (coastal)	Observed
B239	PIGEON GUILLEMOT			Summer	
B244	CASSIN'S AUKLET			Yearlong	
B247	RHINOCEROS AUKLET			Yearlong	
B250	ROCK DOVE		Yearlong		X
B255	MOURNING DOVE		Yearlong		X
B262	BARN OWL	Yearlong	Yearlong		
B264	WESTERN SCREECH OWL		Yearlong		
B265	GREAT HORNED OWL	Yearlong	Yearlong		
B269	BURROWING OWL[2]		Yearlong		
B272	LONG-EARED OWL		Yearlong		
B273	SHORT-EARED OWL	Yearlong	Yearlong		
B275	LESSER NIGHTHAWK	Summer	Summer		
B276	COMMON NIGHTHAWK	Summer	Summer		
B277	COMMON POORWILL		Summer		
B279	BLACK SWIFT		Summer	Summer	
B281	VAUX'S SWIFT	Summer			
B282	WHITE-THROATED SWIFT	Summer	Summer		
B293	BELTED KINGFISHER	Yearlong			
B294	LEWIS' WOODPECKER		Yearlong		
B303	DOWNY WOODPECKER		Yearlong		
B307	NORTHERN FLICKER		Yearlong		
B321	BLACK PHOEBE	Yearlong	Yearlong	Yearlong	
B323	SAY'S PHOEBE		Winter		
B333	WESTERN KINGBIRD	Summer	Summer		
B334	EASTERN KINGBIRD	Migrant	Migrant		
B337	HORNED LARK		Yearlong		
B338	PURPLE MARTIN	Summer	Summer		
B339	TREE SWALLOW	Yearlong	Yearlong		
B340	VIOLET-GREEN SWALLOW	Summer	Yearlong	Summer	
B341	NORTHERN ROUGH-WINGED SWALLOW	Summer	Summer		
B342	BANK SWALLOW	Migrant	Summer	Summer	
B343	CLIFF SWALLOW	Summer	Summer		X
B344	BARN SWALLOW	Summer	Summer	Summer	X
B348	WESTERN SCRUB JAY				X
B352	YELLOW-BILLED MAGPIE		Yearlong		
B353	AMERICAN CROW		Yearlong		X
B354	COMMON RAVEN	Yearlong	Yearlong	Yearlong	X
B366	BUSHTIT				X
B372	MARSH WREN	Yearlong			
B380	WESTERN BLUEBIRD		Yearlong		
B381	MOUNTAIN BLUEBIRD		Yearlong		
B389	AMERICAN ROBIN		Yearlong		
B393	NORTHERN MOCKINGBIRD		Yearlong		
B404	AMERICAN PIPIT	Winter	Winter	Winter	
B410	LOGGERHEAD SHRIKE		Yearlong		
B411	EUROPEAN STARLING	Winter	Yearlong		X
B435	YELLOW-RUMPED WARBLER	Winter	Winter		
B461	COMMON YELLOWTHROAT	Summer	Summer		
B476	BLUE GROSBEAK		Summer		
B487	RUFOUS-CROWNED SPARROW		Yearlong		
B489	CHIPPING SPARROW		Summer		
B494	VESPER SPARROW		Winter		
B495	LARK SPARROW		Yearlong		

Appendix D-2
List of Potential Vertebrate Species in Identified Habitats at the Georgia-Pacific Fort Bragg Facility

		Habitat usage			
CWHRS ID	Species Name	Freshwater Emergent Wetland	Annual Grassland	Marine (coastal)	Observed
B499	SAVANNAH SPARROW		Yearlong		X
B501	GRASSHOPPER SPARROW		Summer		
B505	SONG SPARROW	Yearlong	Yearlong	Yearlong	X
B506	LINCOLN'S SPARROW	Winter	Yearlong		
B509	GOLDEN-CROWNED SPARROW		Winter		
B510	WHITE-CROWNED SPARROW		Winter		X
B514	LAPLAND LONGSPUR		Winter		
B519	RED-WINGED BLACKBIRD	Yearlong	Yearlong		X
B520	TRICOLORED BLACKBIRD	Yearlong	Yearlong		
B521	WESTERN MEADOWLARK		Yearlong		
B522	YELLOW-HEADED BLACKBIRD	Yearlong	Summer		
B524	BREWER'S BLACKBIRD	Yearlong	Yearlong	Yearlong	X
B528	BROWN-HEADED COWBIRD	Yearlong	Yearlong		
B538	HOUSE FINCH		Yearlong		X
B542	PINE SISKIN		Winter		
B543	LESSER GOLDFINCH		Yearlong		
B544	LAWRENCE'S GOLDFINCH		Yearlong		
B545	AMERICAN GOLDFINCH		Yearlong		
B548	CLARK'S GREBE	Summer		Yearlong	
B603	WOOD STORK			Summer	
B629	PACIFIC GOLDEN-PLOVER	Winter	Winter	Winter	
B648	BAIRD'S SANDPIPER			Summer	
B649	PECTORAL SANDPIPER			Summer	
B655	RED-NECKED PHALAROPE	Winter		Winter	
B656	RED PHALAROPE	Migrant		Yearlong	
B702	CHIMNEY SWIFT	Summer	Summer		
B799	HARRIS'S SPARROW		Winter		
Mammals					
M001	VIRGINIA OPOSSUM	Yearlong	Yearlong		
M003	VAGRANT SHREW	Yearlong	Yearlong		
M005	FOG SHREW	Yearlong			
M006	ORNATE SHREW	Yearlong	Yearlong		
M011	MARSH SHREW	Yearlong			
M015	SHREW-MOLE	Yearlong			
M016	TOWNSEND'S MOLE		Yearlong		
M017	COAST MOLE		Yearlong		
M018	BROAD-FOOTED MOLE		Yearlong		
M021	LITTLE BROWN MYOTIS	Summer	Summer		
M023	YUMA MYOTIS	Yearlong	Yearlong		
M025	LONG-EARED MYOTIS	Yearlong			
M026	FRINGED MYOTIS		Yearlong		
M027	LONG-LEGGED MYOTIS		Yearlong		
M028	CALIFORNIA MYOTIS	Yearlong	Yearlong		
M030	SILVER-HAIRED BAT		Yearlong		
M031	WESTERN PIPISTRELLE		Yearlong		
M032	BIG BROWN BAT	Summer	Yearlong		
M033	WESTERN RED BAT	Summer	Yearlong		
M034	HOARY BAT	Yearlong	Yearlong		
M037	TOWNSEND'S BIG-EARED BAT		Summer		
M038	PALLID BAT		Yearlong		
M039	BRAZILIAN FREE-TAILED BAT	Yearlong	Yearlong		
M045	BRUSH RABBIT		Yearlong		
M047	DESERT COTTONTAIL		Yearlong		

Appendix D-2
List of Potential Vertebrate Species in Identified Habitats at the Georgia-Pacific Fort Bragg Facility

		Habitat usage			
CWHRS ID	Species Name	Freshwater Emergent Wetland	Annual Grassland	Marine (coastal)	Observed
M051	BLACK-TAILED JACKRABBIT		Yearlong		X
M056	YELLOW-CHEEKED CHIPMUNK		Yearlong		
M072	CALIFORNIA GROUND SQUIRREL		Yearlong		
M075	GOLDEN-MANTLED GROUND SQUIRREL		Summer		
M081	BOTTA'S POCKET GOPHER		Yearlong		
M087	SAN JOAQUIN POCKET MOUSE		Yearlong		
M105	CALIFORNIA KANGAROO RAT		Yearlong		
M112	AMERICAN BEAVER	Yearlong	Yearlong		
M113	WESTERN HARVEST MOUSE	Yearlong	Yearlong		
M114	SALT-MARSH HARVEST MOUSE		Summer		
M117	DEER MOUSE	Yearlong	Yearlong		
M119	BRUSH MOUSE		Yearlong		
M120	PINON MOUSE		Yearlong		
M128	BUSHY-TAILED WOODRAT		Yearlong		
M134	CALIFORNIA VOLE	Yearlong	Yearlong		
M135	TOWNSEND'S VOLE	Yearlong	Yearlong		
M136	LONG-TAILED VOLE	Yearlong	Yearlong		
M137	CREEPING VOLE		Yearlong		
M139	COMMON MUSKRAT	Yearlong			
M142	HOUSE MOUSE	Yearlong	Yearlong		
M143	WESTERN JUMPING MOUSE		Yearlong		
M145	COMMON PORCUPINE	Yearlong			
M146	COYOTE	Yearlong	Yearlong		
M147	RED FOX		Yearlong		
M149	GRAY FOX	Yearlong	Yearlong		
M151	BLACK BEAR		Yearlong		
M152	RINGTAIL		Yearlong		
M153	RACCOON	Yearlong	Yearlong	Yearlong	
M157	LONG-TAILED WEASEL		Yearlong		
M158	AMERICAN MINK	Yearlong		Yearlong	
M160	AMERICAN BADGER		Yearlong		
M161	WESTERN SPOTTED SKUNK		Yearlong		
M162	STRIPED SKUNK	Yearlong	Yearlong		
M163	NORTHERN RIVER OTTER	Yearlong		Yearlong	
M165	MOUNTAIN LION		Yearlong		
M166	BOBCAT	Yearlong	Yearlong		
M169	NORTHERN SEA-LION			Yearlong	
M170	CALIFORNIA SEA-LION			Yearlong	
M171	HARBOR SEAL			Yearlong	X
M173	NORTHERN ELEPHANT SEAL			Yearlong	
M176	WILD PIG		Yearlong		
M177	ELK	Yearlong	Yearlong		
M178	FALLOW DEER		Yearlong		
M180	AXIS DEER		Yearlong		
M181	MULE DEER	Yearlong	Yearlong		X
M186	FERAL GOAT		Yearlong		

Notes:

[1]Not present at Ft. Bragg. Outside of range.

[2]No suitable habitat present.

APPENDIX E

ECOLOGICAL TOXICITY REFERENCE VALUES

Appendix E-1
Plant TRVs
Georgia-Pacific Corporation
Fort Bragg, California

Terrestrial and Emergent Plants			Phreatophytes		
Chemical	Soil or Sediment TRV (mg/kg)	Source of TRV	Chemical	Solution TRV (µg/L)	Source of TRV
1,1,1-Trichloroethane	-	-	1,1,1-Trichloroethane	100000	Efroymson et al. 1997a
1,1-Dichloroethene	-	-	1,1-Dichloroethene	10000	PCE as surrogate
1,2-Dichlorobenzene	248	See 1,4-Dichlorobenzene	1,2-Dichlorobenzene	-	-
1,2-Dichloroethene	-	-	1,2-Dichloroethene	10000	PCE as surrogate
1,3-Dichlorobenzene	248	See 1,4-Dichlorobenzene	1,3-Dichlorobenzene	-	-
1,4-Dichlorobenzene	248	Hulzebos et al. 1993	1,4-Dichlorobenzene	-	-
2-Methylnaphthalene	46	Sverdrup et al. 2003 (Phenanthrene as surrogate)	2-Methylnaphthalene	-	-
4,4'-DDD	1	Cole, 1968	4,4'-DDD	-	-
4,4'-DDE	1	Cole, 1968	4,4'-DDE	-	-
4,4'-DDT	1	Cole, 1968	4,4'-DDT	-	-
Acenaphthene	20	Efroymson et al. 1997a	Acenaphthene	100	Efroymson et al. 1997a
alpha-Chlordane	100	Cole, 1968	alpha-Chlordane	-	-
Aluminum	50	Efroymson et al. 1997a	Aluminum	300	Efroymson et al. 1997a
Anthracene	46	Sverdrup et al. 2003 (Phenanthrene as surrogate)	Anthracene	-	-
Antimony	5	Efroymson et al. 1997a	Antimony	-	-
Arsenic	10	Efroymson et al. 1997a	Arsenic	1	Efroymson et al. 1997a
Barium	500	Efroymson et al. 1997a	Barium	-	-
Benzene	200	Toluene as surrogate	Benzene	10000	Toluene as surrogate
Beryllium	10	Efroymson et al. 1997a	Beryllium	500	Efroymson et al. 1997a
Benzo(a)anthracene	46	Sverdrup et al. 2003 (Phenanthrene as surrogate)	Benzo(a)anthracene	-	-
Benzo(a)pyrene	46	Sverdrup et al. 2003 (Phenanthrene as surrogate)	Benzo(a)pyrene	-	-
Benzo(b)fluoranthene	46	Sverdrup et al. 2003 (Phenanthrene as surrogate)	Benzo(b)fluoranthene	-	-
Benzo(g,h,i)perylene	46	Sverdrup et al. 2003 (Phenanthrene as surrogate)	Benzo(g,h,i)perylene	-	-
Benzo(k)fluoranthene	46	Sverdrup et al. 2003 (Phenanthrene as surrogate)	Benzo(k)fluoranthene	-	-
Bis (2-ethylhexyl) phthalate	100	Diethylphthalate as surrogate	Bis (2-ethylhexyl) phthalate	-	-
Boron	0.5	Efroymson et al. 1997a	Boron	1000	Efroymson et al. 1997a
Cadmium	4.00	Efroymson et al. 1997a	Cadmium	100	Efroymson et al. 1997a
Chlordane	100	Cole, 1968	Chlordane	-	-
Chlorobenzene	248	Hulzebos et al. 1993	Chlorobenzene	-	-
Chromium III	5	Draft EPA Eco SSLs	Chromium III	50	Efroymson et al. 1997a
Chromium, hexavalent	5	Draft EPA Eco SSLs	Chromium, hexavalent	50	Efroymson et al. 1997a
Chromium, Total	5	Draft EPA Eco SSLs	Chromium, Total	50	Efroymson et al. 1997a
Chrysene	46	Sverdrup et al. 2003 (Phenanthrene as surrogate)	Chrysene	-	-
Cobalt	38	Kabata-Pendias & Pendias 1984	Cobalt	60	Efroymson et al. 1997a
Copper	93	Kabata-Pendias & Pendias 1984	Copper	60	Efroymson et al. 1997a
Cyanide	-	-	Cyanide	300000	Eisler 1999
Dibenz(a,h)anthracene	46	Sverdrup et al. 2003 (Phenanthrene as surrogate)	Dibenz(a,h)anthracene	-	-
Diethyl phthalate	100	Efroymson et al. 1997a	Diethyl phthalate	20000	Efroymson et al. 1997a

Appendix E-1
Plant TRVs
Georgia-Pacific Corporation
Fort Bragg, California

Terrestrial and Emergent Plants

Chemical	Soil or Sediment TRV (mg/kg)	Source of TRV
di-n-butyl phthalate	200	Efroymson et al. 1997a
Endrin	100	Cole, 1968
Ethylbenzene	200	Toluene as surrogate
Fluoranthene	150	Sverdrup et al. 2003
Fluorene	76	Sverdrup et al. 2003
gamma-Chlordane	100	Cole, 1968
Heptachlor	1	Cole, 1968
Indeno(1,2,3-c,d)pyrene	46	Sverdrup et al. 2003 (Phenanthrene as surrogate)
Lead[a]	50	Efroymson et al. 1997a
m,p-Xylenes	200	Toluene as surrogate
Manganese	2250	Kabata-Pendias & Pendias 1984
Mercury	0.30	Efroymson et al. 1997a
Mercury, Organo-	-	-
Molybdenum	2.0	Efroymson et al. 1997a
Naphthalene	46	Sverdrup et al. 2003 (Phenanthrene as surrogate)
Nickel	30	Efroymson et al. 1997a
o-Xylene	200	Toluene as surrogate
Aroclor 1016	40	Efroymson et al. 1997a
Aroclor 1221	40	Efroymson et al. 1997a
Aroclor 1232	40	Efroymson et al. 1997a
Aroclor 1242	40	Efroymson et al. 1997a
Aroclor 1248	40	Efroymson et al. 1997a
Aroclor 1254	40	Efroymson et al. 1997a
Aroclor 1260	40	Efroymson et al. 1997a
Pentachlorophenol	3	Efroymson et al. 1997a
Perchlorate	40	U.S. Air Force 1998
Phenanthrene	46	Sverdrup et al. 2003
Phenol	70	Efroymson et al. 1997a
Pyrene	56	Sverdrup et al. 2003
Selenium	1	Efroymson et al. 1997a
Silver	2.0	Efroymson et al. 1997a
Tetrachloroethene	-	-
Thallium	1	Efroymson et al. 1997a
Toluene	200	Efroymson et al. 1997a
Trichloroethene	-	-
Vanadium	75	Kabata-Pendias & Pendias 1984
Xylenes (total)	200	Toluene as surrogate
Zinc	50	Efroymson et al. 1997a

Phreatophytes

Chemical	Solution TRV (µg/L)	Source of TRV
di-n-butyl phthalate	-	-
Endrin	-	-
Ethylbenzene	10000	Toluene as surrogate
Fluoranthene	-	-
Fluorene	-	-
gamma-Chlordane	-	-
Heptachlor	-	-
Indeno(1,2,3-c,d)pyrene	-	-
Lead	20	Efroymson et al. 1997a
m,p-Xylenes	100000	See Xylenes (total)
Manganese	4000	Efroymson et al. 1997a
Mercury	5	Efroymson et al. 1997a
Mercury, Organo-	0.2	Efroymson et al. 1997a
Molybdenum	500	Efroymson et al. 1997a
Naphthalene	10000	Efroymson et al. 1997a
Nickel	500	Efroymson et al. 1997a
o-Xylene	100000	See Xylenes (total)
Aroclor 1016	-	-
Aroclor 1221	-	-
Aroclor 1232	-	-
Aroclor 1242	-	-
Aroclor 1248	-	-
Aroclor 1254	-	-
Aroclor 1260	-	-
Pentachlorophenol	30	Efroymson et al. 1997a
Perchlorate	-	-
Phenanthrene	-	-
Phenol	10000	Efroymson et al. 1997a
Pyrene	-	-
Selenium	700	Efroymson et al. 1997a
Silver	100	Efroymson et al. 1997a
Tetrachloroethene	10000	Efroymson et al. 1997a
Thallium	50	Efroymson et al. 1997a
Toluene	10000	Efroymson et al. 1997a
Trichloroethene	10000	PCE as surrogate
Vanadium	200	Efroymson et al. 1997a
Xylenes (total)	100000	Efroymson et al. 1997a
Zinc	400	Efroymson et al. 1997a

a - The soil-to-plant lead TRV was based on lead acetate.

Appendix E-2
Soil Invertebrate TRVs
Georgia-Pacific Corporation
Fort Bragg, California

Chemical	TRV (mg/kg_{soil})	Source of TRV
1,2,3,4,6,7,8-HpCDD	5	2,3,7,8-TCDD as surrogate
1,2,3,4,6,7,8-HpCDF	5	2,3,7,8-TCDD as surrogate
1,2,3,4,7,8,9-HpCDF	5	2,3,7,8-TCDD as surrogate
1,2,3,4,7,8-HxCDF	5	2,3,7,8-TCDD as surrogate
1,2,3,6,7,8-HxCDD	5	2,3,7,8-TCDD as surrogate
1,2,3,6,7,8-HxCDF	5	2,3,7,8-TCDD as surrogate
1,2,3,7,8-PeCDF	5	2,3,7,8-TCDD as surrogate
1,2,3-Trichlorobenzene	20	Efroymson et al. 1997b
1,2,4-Trichlorobenzene	20	Efroymson et al. 1997b
1,2-Dichlorobenzene	20	See 1,4-Dichlorobenzene
1,3-Dichlorobenzene	20	See 1,4-Dichlorobenzene
1,4-Dichlorobenzene	20	Efroymson et al. 1997b
2,3,4,6,7,8-HxCDF	5	2,3,7,8-TCDD as surrogate
2,3,4,7,8-PeCDF	5	2,3,7,8-TCDD as surrogate
2,3,7,8-TCDD	5	Reinecke and Nash 1984
2,3,7,8-TCDF	5	2,3,7,8-TCDD as surrogate
2-Methylnaphthalene	20	Sverdrup et al. 2002a (Naphthalene as surrogate)
Anthracene	360	Sverdrup et al. 2002a (Benzo(b)fluoranthene as surrogate)
Aroclor 1248	500	Parmelee 1997
Aroclor 1254	500	Parmelee 1997
Aroclor 1260	500	Parmelee 1997
Arsenic	60	Efroymson et al. 1997b
Benzo(a)anthracene	980	Sverdrup et al. 2002a
Benzo(a)pyrene	360	Sverdrup et al. 2002a (Benzo(b)fluoranthene as surrogate)
Benzo(b)fluoranthene	360	Sverdrup et al. 2002a
Benzo(g,h,i)perylene	360	Sverdrup et al. 2002a (Benzo(b)fluoranthene as surrogate)
Benzo(k)fluoranthene	560	Sverdrup et al. 2002a
Cadmium	20	Efroymson et al. 1997b
Chlorobenzene	40	Efroymson et al. 1997b
Chromium III	0.4	Efroymson et al. 1997b
Chromium, hexavalent	0.4	Efroymson et al. 1997b
Chromium, Total	0.4	Efroymson et al. 1997b
Chrysene	1030	Sverdrup et al. 2002a
Copper	60	Efroymson et al. 1997b
Dibenz(a,h)anthracene	780	Sverdrup et al. 2002a
Fluoranthene	15	Sverdrup et al. 2002b
Fluorene	7.7	Sverdrup 2001
HxCDD (Total)	5	2,3,7,8-TCDD as surrogate
HxCDF (total)	5	2,3,7,8-TCDD as surrogate
Indeno(1,2,3-c,d)pyrene	910	Sverdrup et al. 2002a
Lead	500	Efroymson et al. 1997b
Mercury	0.1	Efroymson et al. 1997b
Naphthalene	20	Sverdrup et al. 2002a
Nickel	200	Efroymson et al. 1997b
OCDD	5	2,3,7,8-TCDD as surrogate

Appendix E-2
Soil Invertebrate TRVs
Georgia-Pacific Corporation
Fort Bragg, California

Chemical	TRV (mg/kg_{soil})	Source of TRV
OCDF	5	2,3,7,8-TCDD as surrogate
PeCDF (total)	5	2,3,7,8-TCDD as surrogate
Pentachlorophenol	6	Efroymson et al. 1997b
Perchlorate	890	U.S. Air Force 1998
Phenanthrene	23	Sverdrup 2001
Phenol	30	Efroymson et al. 1997b
Pyrene	10	Sverdrup 2001
Selenium	70	Efroymson et al. 1997b
TCDF (total)	5	2,3,7,8-TCDD as surrogate
Total PCBs	500	Parmelee 1997
Zinc	100	Efroymson et al. 1997b

Appendix E-3
Aquatic Plant and Invertebrate TRVs
Georgia-Pacific Corporation
Fort Bragg, California

Chemical	TRV (µg/L)	Source of TRV
1,1,1-Trichloroethane	11	U.S. EPA 1993
1,1,2-Trichloroethane	11	Trichloroethane surrogate
1,1-Dichloroethene	25	U.S. EPA 1993
1,2-Dichlorobenzene	15	See 1,4-Dichlorobenzene
1,2-Dichloroethane	910	U.S. EPA 1993
1,2-Dichloroethene	590	U.S. EPA 1993
1,2-Dichloropropane	5,700	U.S. EPA 1986
1,3-Dichlorobenzene	15	See 1,4-Dichlorobenzene
1,4-Dichlorobenzene	15	U.S. EPA 1993
2,3,7,8-TCDD	0.0031	U.S. EPA 1995
2-Butanone (MEK)	14000	U. S. EPA 1993
2-Methylphenol	13	U.S. EPA 1986
4,4'-DDD	0.1	U.S. EPA 1993
4,4'-DDE	0.1	U.S. EPA 1993
4,4'-DDT	0.1	U.S. EPA 1993
Acetone	1,500	U.S. EPA 1993
Aldrin	0.0019	U.S. EPA 1986
alpha BHC	0.08	See gamma BHC
alpha Endosulfan	0.051	See Endosulfan
alpha-Chlordane	0.0043	See Chlordane
Aluminum	87	Suter and Tsao 1996
Antimony	30	U.S. EPA 1986
Aroclor 1016	0.014	Cal Toxics Rule
Aroclor 1221	0.014	Cal Toxics Rule
Aroclor 1232	0.014	Cal Toxics Rule
Aroclor 1242	0.014	Cal Toxics Rule
Aroclor 1248	0.014	Cal Toxics Rule
Aroclor 1254	0.014	Cal Toxics Rule
Aroclor 1260	0.014	Cal Toxics Rule
Arsenic	190	U.S. EPA 1986
Barium	4.0	U.S. EPA 1993
Benzene	130	U.S. EPA 1993
Benzo(a)anthracene	0.014	Benzo(a)pyrene as surrogate
Benzo(a)pyrene	0.014	U.S. EPA 1993
Benzo(b)fluoranthene	0.014	Benzo(a)pyrene as surrogate
Benzo(g,h,i)perylene	0.014	Benzo(a)pyrene as surrogate
Benzo(k)fluoranthene	0.014	Benzo(a)pyrene as surrogate
Benzoic acid	42	U. S. EPA 1993
Beryllium	0.66	U.S. EPA 1993
beta BHC	0.08	See gamma BHC
beta Endosulfan	0.051	See Endosulfan
Bromoform	293	Suter and Tsao 1996
Cadmium[a]	2.2	Cal Toxics Rule
Carbon disulfide	0.92	U. S. EPA 1993
Chlordane	0.0043	U.S. EPA 1986
Chlorobenzene	64	U.S. EPA 1993

Appendix E-3
Aquatic Plant and Invertebrate TRVs
Georgia-Pacific Corporation
Fort Bragg, California

Chemical	TRV (µg/L)	Source of TRV
Chloroform	289	Suter and Tsao 1996
Chromium III[a]	180	Cal Toxics Rule
Chromium, hexavalent	11	Cal Toxics Rule
Chromium,Total[a]	180	Cal Toxics Rule
Chrysene	0.014	Benzo(a)pyrene as surrogate
cis-1,2-Dichloroethene	590	See 1,2-Dichloroethene
Cobalt	23	U.S. EPA 1993
Copper[a]	9	Cal Toxics Rule
Cyanide	20	Eisler 1999
Dieldrin	0.0019	U.S. EPA 1986
Endosulfan	0.051	U.S. EPA 1993
Ethylbenzene	7.3	U.S. EPA 1993
gamma BHC	0.08	U.S. EPA 1986
gamma-Chlordane	0.0043	See Chlordane
Heptachlor	0.0038	U.S. EPA 1993
Iron	1000	Suter and Tsao 1996
Lead[a]	2.5	Cal Toxics Rule
m,p-Xylenes	13	See Xylenes, Total
Manganese	120	U.S. EPA 1993
Mercury	0.2	U.S. EPA 1986
Molybdenum	370	U.S. EPA 1993
Naphthalene	12	U.S. EPA 1993
Nickel	52	Cal Toxics Rule
o-Xylene	13	See Xylenes, Total
Phenanthrene	12	Naphthalene as surrogate
Pyrene	0.014	Benzo(a)pyrene as surrogate
p-cymene (p-isopropyltoluene)	7.3	Toluene as surrogate
Pentachlorophenol	15	Cal Toxics Rule
Selenium	5	U.S. EPA 1986
Silver[a]	3.4	Cal Toxics Rule
Tetrachloroethene	98	U.S. EPA 1993
Thallium	12	U.S. EPA 1993
Toluene	9.8	U.S. EPA 1993
trans-1,2-Dichloroethene	590	See 1,2-Dichloroethene
Trichloroethene	47	U.S. EPA 1993
Vanadium	20	U.S. EPA 1993
Xylenes (total)	13	U.S. EPA 1993
Zinc[a]	120	Cal Toxics Rule

a - Where hardness values are available, hardness-dependent TRVs are calculated from Cal Toxics Rule formulas (Cal EPA 2000).

	Primary Study Information:						Uncertainty Factors						
Chemical:	**Test Species**	**Observed Effect**	**Chronic/ Subchronic**	**Effect level**	**Body Weight (kg)**	**Non-adjusted TRV (mg/kg-day)**	**Non-sensitive to sensitive**	**Subchronic to Chronic UF**	**LOAELto NOAELUF**	**Adjusted NOAEL-Equivalent TRV (mg/kg-day)**	**Sample & Arenal 1999 Mammalian Allometric Scaling**	**Source of TRV**	**Source/TRV Provided by:**
Metals:													
Aluminum	Mouse	Reproduction	Chronic	NOAEL	0.03	1.93	-	-	-	1.93	0.94	Ondreickaet al. 1966	Rocketdyne 2003
Antimony	Rat	Histological and biochemical changes	Subchronic	NOAEL	0.127	0.06	-	2	-	0.03	0.94	Poon et al. 1998	HERD VAFB Memo 4/2002
Arsenic	Rat	Reproduction	Chronic	NOAEL	0.25	0.32	-	-	-	0.32	0.874	EFA West, 1998	EFA West, 1998
Barium	Rat	Growth, development at sensitive life stage	Chronic	NOAEL	0.435	5.1	-	-	-	5.1	0.746	Perry et al. 1983	U.S. Air Force, 2004
Beryllium	Rat	Longevity, survival, growth (sensitive life stage)	Chronic	NOAEL	0.35	0.66	-	-	-	0.66	0.94	Schroeder and Mitchner, 1975	U.S. Air Force, 2004
Boron	Rat	Reproduction	Chronic	NOAEL	0.35	28	-	-	-	28	0.94	Weir and Fisher, 1972	Sample et al., 1996
Cadmium	Mouse	Reproduction	Chronic	NOAEL	0.0322	0.06	-	-	-	0.06	0.893	EFA West, 1998	EFA West, 1998
Chromium, hexavalent	Rat	Growth, pathology	Chronic	NOAEL	0.35	3.28	-	-	-	3.28	0.94	Mackenzie et al., 1958	Rocketdyne, 2003
Chromium, Total	Rat	Growth, organ weight, blood chemistry	Chronic	NOAEL	0.35	1468	-	-	-	1468	0.94	IRIS (Ivankovic and Preussman, 1975)	Rocketdyne, 2003
Cobalt	Rat	Reproduction (decreased pup growth)	Chronic	NOAEL	0.35	1.2	-	-	-	1.2	0.94	EFA West, 1998	EFA West, 1998
Copper	Mouse	Growth, thymic cell count, mortality	Chronic	NOAEL	0.03	2.667	-	-	-	2.667	0.94	EFA West, 1998	EFA West, 1998
Cyanide	Rat	Reproduction	Chronic	NOAEL	0.273	68.7	-	-	-	68.7	0.94	Sample et al. 1996	Rocketdyne, 2003
Lead	Rat	Kidney Function	Chronic	NOAEL	0.35	1	-	-	-	1	0.94	Fowler et al. 1980	DTSC, 2002
Manganese	Mouse	Reproductive Organ Toxicity	Chronic	NOAEL	0.0346	13.7	-	-	-	13.7	0.94	EFA West, 1998	EFA West, 1998
Mercury	Rat	Reproduction and development	Chronic	NOAEL	0.1875	0.25	-	-	-	0.25	0.983	EFA West, 1998	EFA West, 1998
Molybdenum	Mouse	Reproduction	Chronic	NOAEL	0.03	0.26	-	-	-	0.26	0.94	Schroeder and Mitchner, 1971	Rocketdyne, 2003
Nickel	Rat	Reproduction	Chronic	NOAEL	0.248	0.133	-	-	-	0.133	0.94	EFA West, 1998	EFA West, 1998
Selenium	Mouse	Hepatic lesions	Chronic	NOAEL	0.0246	0.05	-	-	-	0.05	0.94	EFA West, 1998	EFA West, 1998
Silver	Mouse	Hypoactivity	Subchronic	LOAEL	0.024	3.75	-	-	10	0.375	0.94	EPA Region 6	Rocketdyne, 2003
Strontium	Rat	Body weight and bone changes	Chronic	NOAEL	0.25	263	-	-	-	263	0.94	Skyorna 1981	Sample et al. 1996, IRIS
Thallium	Rat	Hair loss	Chronic	NOAEL	0.065	0.48	*	-	-	0.48	0.808	EFA West, 1998	EFA West, 1998
Titanium	Rat	Reproduction, fertility	Chronic	LOAEL	0.35	0.746	-	-	5	0.1492	0.94	Schroeder and Mitchner, 1971	Ecotox, WHO 1982
Vanadium	Rat	Reproduction	Chronic	NOAEL	0.26	0.21	-	-	-	0.21	0.94	Domingo et al. 1986	Rocketdyne, 2003
Zinc	Mouse	Hypertrophy	Chronic	NOAEL	0.0255	9.6	-	-	-	9.6	0.851	EFA West, 1998	EFA West, 1998
Organics:													
1,1,1-Trichloroethane	Mouse	Developmental	Chronic	NOAEL	0.035	1000	-	-	-	1000	0.648	Lane et al., 1982	U.S. Air Force, 2004
1,1,2-Trichloroethane	Mouse	Hematology	Subchronic	NOAEL	0.03	3.9	-	2	-	1.95	0.94	IRIS (White et al., 1985)	Rocketdyne, 2003
1,1-Dichloroethene	Dog	Organ toxicity, mortality	Chronic	NOAEL	14	2.5	-	-	-	2.5	1.539	Sample et al. 1996	Rocketdyne, 2003
1,1-Dichloropropene	Rat	Decreased body weight, changes in organ weight	Chronic	NOAEL	0.35	5	-	-	-	5	0.94	Haut et al. 1996 (1,3-Dichloropropene)	IRIS
1,2,3,4,6,7,8-HpCDD	Rat	growth, organ toxicity, blood chemistry	Chronic	NOAEL	0.35	0.0001	-	-	-	0.0001	0.537	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
1,2,3,6,7,8-HxCDD	Rat	growth, organ toxicity, blood chemistry	Chronic	NOAEL	0.35	0.00001	-	-	-	0.00001	0.94	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
1,2,3,4,6,7,8-HpCDF	Rat	growth, organ toxicity, blood chemistry	Chronic	NOAEL	0.35	0.0001	-	-	-	0.0001	0.94	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
1,2,3,4,7,8,9-HpCDF	Rat	growth, organ toxicity, blood chemistry	Chronic	NOAEL	0.35	0.0001	-	-	-	0.0001	0.94	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
1,2,3,4,7,8-HxCDF	Rat	growth, organ toxicity, blood chemistry	Chronic	NOAEL	0.35	0.00001	-	-	-	0.00001	0.94	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
1,2,3,6,7,8-HxCDF	Rat	growth, organ toxicity, blood chemistry	Chronic	NOAEL	0.35	0.00001	-	-	-	0.00001	0.94	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
1,2,3,7,8-PeCDF	Rat	growth, organ toxicity, blood chemistry	Chronic	NOAEL	0.35	0.00002	-	-	-	0.00002	0.94	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
1,2,3-Trichlorobenzene	Rat	Reproduction	Chronic	NOAEL	0.35	14.8	-	-	-	14.8	0.94	IRIS (1,2,4-Trichlorobenzene)	Rocketdyne, 2003
1,2,4-Trichlorobenzene	Rat	Reproduction	Chronic	NOAEL	0.35	14.8	-	-	-	14.8	0.94	IRIS (Robinson et al., 1981)	Rocketdyne, 2003
1,2,4-Trimethylbenzene	Rat	Liver to body weight ratio	Subchronic	LOAEL	0.35	150	-	-	10	15	0.94	Xylenes (total) as surrogate	Tetra Tech, 2002
1,2-Dibromo-3-chloropropane	Rat	Growth, histology	Chronic	LOAEL	0.35	5.1	-	-	5	1.02	0.94	IRIS (1,3-Dichloropropene)	Rocketdyne, 2003
1,2-Dichlorobenzene	Rat	Organ toxicity	Chronic	NOAEL	0.35	85.7	-	-	-	85.7	0.94	IRIS (NTP, 1985)	Rocketdyne, 2003
1,2-Dichloroethane	Mouse	Reproduction	Chronic	NOAEL	0.035	50	-	-	-	50	0.835	Lane et al., 1982	U.S. Air Force, 2004
1,2-Dichloroethene	Rat	Histopathology, reproductive organs	Subchronic	NOAEL	0.25	872	-	2	-	436	0.94	McCauley et al. 1990	U.S. Air Force, 2004
1,3,5-Trimethylbenzene	Rat	Liver to body weight ratio	Subchronic	LOAEL	0.35	150	-	-	10	15	0.94	Xylenes (total) as surrogate	Tetra Tech, 2002
1,3-Dichlorobenzene	Rat	Body weight gain	Subchronic	NOAEL	0.35	53.6	10	2	-	2.68	0.94	ATSDR (1,4-Dichlorobenzene)	Rocketdyne, 2003
1,4-Dichlorobenzene	Rat	Body weight gain	Subchronic	NOAEL	0.35	53.6	10	2	-	2.68	0.94	Lake et al. 1997	Rocketdyne, 2003
2,3,7,8-TCDD	Rat	growth, organ toxicity, blood chemistry	Chronic	NOAEL	0.35	0.000001	-	-	-	0.000001	0.537	Sample et al. 1996	Rocketdyne, 2003
2,3,7,8-TCDF	Rat	growth, organ toxicity, blood chemistry	Chronic	NOAEL	0.35	0.00001	-	-	-	0.00001	0.94	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
2,3,4,6,7,8-HxCDF	Rat	growth, organ toxicity, blood chemistry	Chronic	NOAEL	0.35	0.00001	-	-	-	0.00001	0.94	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
2,3,4,7,8-PeCDF	Rat	growth, organ toxicity, blood chemistry	Chronic	NOAEL	0.35	0.000002	-	-	-	0.000002	0.94	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
2-Butanone (MEK)	Rat	Reproduction	Chronic	NOAEL	0.35	1771	-	-	-	1771	0.94	IRIS (Cox et al., 1975)	Rocketdyne, 2003
2-Hexanone	Rat	-- Not available --	Subchronic	LOAEL	0.35	570	10	-	10	5.7	0.94	HEAST FY 1997 (Hexane)	Rocketdyne, 2003
2-Methylnaphthalene	Rat	Body weight gain (sensitive life stage)	Chronic	NOAEL	0.2765	50	*	-	-	50	0.94	EFA West, 1998 (napthalene)	Rocketdyne, 2003
4,4'-DDD	Rat	Reproduction	Chronic	NOAEL	0.32	0.8	-	-	-	0.8	1.268	EFA West, 1998	EFA West, 1998
4,4'-DDE	Rat	Reproduction	Chronic	NOAEL	0.32	0.8	-	-	-	0.8	1.268	EFA West, 1998	EFA West, 1998
4,4'-DDT	Rat	Reproduction	Chronic	NOAEL	0.32	0.8	-	-	-	0.8	1.268	EFA West, 1998	EFA West, 1998
4-Methyl-2-pentanone (MIBK)	Rat	-- Not available --	Subchronic	LOAEL	0.35	570	10	-	10	5.7	0.94	HEAST FY 1997 (Hexane)	Rocketdyne, 2003
4-Methylphenol	Rat	Decreased body and organ weights, food consum	Subchronic	NOAEL	0.35	50	-	2	-	25	0.94	U.S. EPA 1986 (2-Methylphenol)	IRIS
Acenaphthylene	Mouse	Growth, organ toxicity	Subchronic	NOAEL	0.03	175	-	2	-	87.5	0.94	IRIS (Acenaphthene - U.S. EPA, 1989a)	Rocketdyne, 2003
Acetone	Rat	Kidney and liver toxicity	Chronic	NOAEL	0.35	10	-	-	-	10	1.128	Sample et al. 1996	Rocketdyne, 2003
alpha-Chlordane	Mouse	Liver toxicity	Chronic	NOAEL	0.03	0.12	-	-	-	0.12	0.829	Khasawinah and Grutsch 1989 (Chlordane)	Rocketdyne, 2003
Anthracene	Mouse	Growth, histology	Subchronic	NOAEL	0.03	1000	-	2	-	500	0.94	IRIS (U.S. EPA 1989)	Rocketdyne, 2003

	Primary Study Information:						Uncertainty Factors						
Chemical:	**Test Species**	**Observed Effect**	**Chronic/ Subchronic**	**Effect level**	**Body Weight (kg)**	**Non-adjusted TRV (mg/kg-day)**	**Non-sensitive to sensitive**	**Subchronic to Chronic UF**	**LOAELto NOAELUF**	**Adjusted NOAEL-Equivalent TRV (mg/kg-day)**	**Sample & Arenal 1999 Mammalian Allometric Scaling**	**Source of TRV**	**Source/TRV Provided by:**
Aroclor 1248[c]	Mouse	Liver toxicity	Chronic	NOAEL	0.02062	0.36	-	-	-	0.36	0.94	EFA West, 1998	EFA West, 1998
Aroclor 1254[c]	Mouse	Liver toxicity	Chronic	NOAEL	1.02062	0.36	-	-	-	0.36	0.94	EFA West, 1998	EFA West, 1998
Aroclor 1260[c]	Mouse	Liver toxicity	Chronic	NOAEL	2.02062	0.36	-	-	-	0.36	0.94	EFA West, 1998	EFA West, 1998
Benzene	Mouse	Erythrocyte and lymphocyte counts	Subchronic	LOAEL	0.03	8	-	-	10	0.8	0.818	Tech Memo	Tetra Tech, 2002
Benzo(a)anthracene	Mouse	Longevity, pulmonary edema	Chronic	NOAEL	0.0305	1.31	-	-	-	1.31	0.94	EFA West, 1998 (benzo(a)pyrene)	EFA West, 1998
Benzo(a)pyrene	Mouse	Longevity, pulmonary edema	Chronic	NOAEL	0.0305	1.31	-	-	-	1.31	0.94	EFA West, 1998	EFA West, 1998
Benzo(b)fluoranthene	Mouse	Longevity, pulmonary edema	Chronic	NOAEL	0.0305	1.31	-	-	-	1.31	0.94	EFA West, 1998 (benzo(a)pyrene)	EFA West, 1998
Benzo(g,h,i)perylene	Mouse	Longevity, pulmonary edema	Chronic	NOAEL	0.0305	1.31	-	-	-	1.31	0.94	EFA West, 1998 (benzo(a)pyrene)	EFA West, 1998
Benzo(k)fluoranthene	Mouse	Longevity, pulmonary edema	Chronic	NOAEL	0.0305	1.31	-	-	-	1.31	0.94	EFA West, 1998 (benzo(a)pyrene)	EFA West, 1998
Bis(2-ethylhexyl) Phthalate (BEHP)	Mouse	Reproduction	Chronic	NOAEL	0.03	18.3	-	-	-	18.3	1.531	Lamb et al., 1987	Sample et al., 1996
Bromodichloromethane	Mouse	Kidney toxicity	Chronic	LOAEL	0.03	17.9	-	-	5	3.58	0.94	IRIS (NTP 1986)	Rocketdyne, 2003
Bromoform	Rat	Organ toxicity	Subchronic	NOAEL	0.35	17.9	-	2	-	8.95	0.94	IRIS (NTP 1989)	Rocketdyne, 2003
Carbon tetrachloride	Rat	Liver toxicity	Subchronic	NOAEL	0.35	0.71	-	2	-	0.355	0.703	IRIS (Bruckner et al., 1986)	Rocketdyne, 2003
Chloroform	Dog	Liver toxicity	Chronic	LOAEL	14	1	-	-	5	0.2	1.192	IRIS (Heywood et al., 1979)	Rocketdyne, 2003
Chrysene	Mouse	Longevity, pulmonary edema	Chronic	NOAEL	0.0305	1.31	-	-	-	1.31	0.94	EFA West, 1998 (benzo(a)pyrene)	EFA West, 1998
Dalapon	Rat	Kidney-to-body weight ratio	Chronic	NOAEL	0.35	15	-	-	-	15	0.94	Paytner et al. 1960	IRIS
Dibenzo(a,h)anthracene	Mouse	Longevity, pulmonary edema	Chronic	NOAEL	0.0305	1.31	-	-	-	1.31	0.94	EFA West, 1998 (benzo(a)pyrene)	EFA West, 1998
Dibromochloromethane	Rat	Hepatic lesions	Subchronic	NOAEL	0.35	21.4	-	2	-	10.7	0.94	IRIS (NTP 1985)	Rocketdyne, 2003
Dichlorodifluoromethane (Freon 12)	Rat	Decreased weight gain	Chronic	NOAEL	0.35	15	10	-	-	1.5	0.94	IRIS (Sherman, 1974)	
Dieldrin	Rat	Reproduction	Chronic	LOAEL	0.35	0.2	-	-	5	0.04	0.94	Treon and Cleveland 1955	Rocketdyne, 2003
Diethyl phthalate (DEP)	Rat	Growth, food consumption, organ weight	Subchronic	NOAEL	0.35	750	-	2	-	375	0.716	IRIS (Brown et al., 1978)	
di-n-butyl phthalate	Rat	Reproduction (decreased pup weight)	Chronic	NOAEL	0.35	120	-	-	-	120	1.345	Killenger et al. 1988 (ATSDR)	Rocketdyne, 2003
Endrin	Dog (Beag	Convulsions, liver weight, liver histolopathological	Chronic	NOAEL	12.7	0.025	-	-	-	0.025	0.967	Velsicol Chemical Corporation. 1969	IRIS
Endrin aldehyde	Dog (Beag	Convulsions, liver weight, liver histolopathological	Chronic	NOAEL	12.7	0.025	-	-	-	0.025	0.967	Velsicol Chemical Corporation. 1969	IRIS
Ethylbenzene	Mouse	Rotorod performance	Subchronic	LOAEL	0.03	3.2	-	-	10	0.32	0.94	Tech Memo (Toluene)	Tetra Tech, 2002
Fluoranthene	Mouse	Liver and kidney toxicity, hematology	Subchronic	NOAEL	0.03	125	-	2	-	62.5	0.94	IRIS (U.S. EPA, 1988)	Rocketdyne, 2003
Fluorene	Mouse	Hematology	Subchronic	NOAEL	0.03	125	-	2	-	62.5	0.94	IRIS (U.S. EPA, 1988)	Rocketdyne, 2003
gamma-Chlordane	Mouse	Liver toxicity	Chronic	NOAEL	0.03	0.12	-	-	-	0.12	0.829	Khasawinah and Grutsch 1989 (Chlordane)	Rocketdyne, 2003
HpCDD (total)	Rat	growth, organ toxicity, blood chemistry	Chronic	NOAEL	0.35	0.0001	-	-	-	0.0001	0.94	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
HxCDD (total)	Rat	growth, organ toxicity, blood chemistry	Chronic	NOAEL	0.35	0.00001	-	-	-	0.00001	0.94	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
HxCDF (total)	Rat	growth, organ toxicity, blood chemistry	Chronic	NOAEL	0.35	0.00001	-	-	-	0.00001	0.94	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
Indeno(1,2,3-cd)pyrene	Mouse	Longevity, pulmonary edema	Chronic	NOAEL	0.0305	1.31	-	-	-	1.31	0.94	EFA West, 1998 (benzo(a)pyrene)	EFA West, 1998
Isopropylbenzene (cumene)	Mouse	Rotorod performance	Subchronic	LOAEL	0.03	3.2	-	-	10	0.32	0.94	Tech Memo (Ethylbenzene)	Tetra Tech, 2002
m,p-Xylenes	Rat	Liver to body weight ratio	Subchronic	LOAEL	0.35	150	-	-	10	15	0.94	Xylenes (total) as surrogate	Tetra Tech, 2002
Methanol	Rat	Mortality, blood chemistry, liver and brain weights	Subchronic	NOAEL	0.35	500	10	2	-	25	0.94	Sample et al. 1996	Rocketdyne, 2003
Methoxychlor	Rat	Increase in pituitary prolactin content	Chronic	LOAEL	0.35	25	-	-	10**	2.5	1.224	Gray et al. 1989	EFA West, 1998
Methylene Chloride	Rat	Liver histology	Chronic	NOAEL	0.35	5.85	-	-	-	5.85	0.94	Sample et al. 1996	Rocketdyne, 2003
Naphthalene	Rat	Body weight gain	Chronic	NOAEL	0.2765	50	*	-	-	50	0.94	EFA West, 1998	EFA West, 1998
n-Butylbenzene	Mouse	Rotorod performance	Subchronic	LOAEL	0.03	3.2	-	-	10	0.32	0.94	Tech Memo (Ethylbenzene)	Tetra Tech, 2002
n-Propylbenzene	Mouse	Rotorod performance	Subchronic	LOAEL	0.03	3.2	-	-	10	0.32	0.94	Tech Memo (Ethylbenzene)	Tetra Tech, 2002
OCDD	Rat	growth, organ toxicity, blood chemistry	Chronic	NOAEL	0.35	0.01	-	-	-	0.01	0.537	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
OCDF	Rat	growth, organ toxicity, blood chemistry	Chronic	NOAEL	0.35	0.01	-	-	-	0.01	0.537	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
o-Xylene	Rat	Liver to body weight ratio	Subchronic	LOAEL	0.35	150	-	-	10	15	0.94	Xylenes (total) as surrogate	Tetra Tech, 2002
p-cymene (p-isopropyltoluene)	Rat	Liver to body weight ratio	Subchronic	LOAEL	0.35	150	-	-	10	15	0.94	Xylenes (total) as surrogate	Tetra Tech, 2002
PeCDF (total)	Rat	growth, organ toxicity, blood chemistry	Chronic	NOAEL	0.35	0.000002	-	-	-	0.000002	0.94	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
Phenanthrene	Mouse	Kidney toxicity	Subchronic	NOAEL	0.03	75	-	2	-	37.5	0.94	IRIS (Pyrene)	Rocketdyne, 2003
Perchlorate[d]	Rat	Reproduction	Chronic	NOAEL	0.35	30	-	-	-	30	0.94	York et al. 2001	U.S. EPA 2002b
Perchlorate[e]	Rat	hyperplasia, hormone levels	Chronic	LOAEL	0.35	0.1	-	-	5	0.02	0.94	Argus Research Laboratories, 1998 a,b,c	U.S. EPA 2002b
Pyrene	Mouse	Kidney toxicity	Subchronic	NOAEL	0.03	75	-	2	-	37.5	0.94	IRIS (U.S. EPA, 1989b)	Rocketdyne, 2003
sec-butylbenzene	Mouse	Rotorod performance	Subchronic	LOAEL	0.03	3.2	-	-	10	0.32	0.94	Tech Memo (Ethylbenzene)	Tetra Tech, 2002
TCDF (total)	Rat	growth, organ toxicity, blood chemistry	Chronic	NOAEL	0.35	0.00001	-	-	-	0.00001	0.94	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
Tetrachloroethene	Mouse	Locomotion and total activity	Chronic	LOAEL	0.03	5	-	-	5	1	1.05	Tech Memo	Tetra Tech, 2002
Toluene	Mouse	Rotorod performance	Subchronic	LOAEL	0.03	3.2	-	-	10	0.32	0.94	Tech Memo	Tetra Tech, 2002
Trichloroethene	Mouse	Hepatotoxicity, relative liver weight	Chronic	LOAEL	0.03	7	-	-	5	1.4	1.111	Tech Memo	Tetra Tech, 2002
Xylenes (total)	Rat	Liver to body weight ratio	Subchronic	LOAEL	0.35	150	-	-	10	15	0.94	Tech Memo	Tetra Tech, 2002

Notes:

a - If the body weight of the receptor differs from the body weight of the test animal, an allometric scaling factor is applied (Sample and Arenal, 1999): $TRV_{adjusted} = TRV_{unadjusted} * (BW_{TestSpecies}/BW_{Receptor})$^(1-Scaling Factor)

b - Taxonomic Uncertainty factors are applied to the TRVs as follows: UF of 5 is applied to the kangaroo rats, and a UF of 10 is applied to the Kit Fox (USGS 2001).

c - Total PCBs used as surrogate for Arochlor benchmark.

d, e - Two different TRVs were selected for perchlorate to evaluate the full range of toxic effects.

* - Navy BTAG number; no additional UF applied.

** - UF is taken from the EFB West document.

IRIS refers to the on-line Integrated Risk Information System, U.S. EPA 2004a

Ecotox refers to the on-line Ecotox database, U.S. EPA 2004b

Appendix E-5
Mammal TRV - Highs
Georgia-Pacific Corporation
Fort Bragg, California

Chemical:	Test Species	Observed Effect (Primary Study Information:)	Chronic/ Subchronic	Effect level	Body Weight (kg)	Non-adjusted TRV (mg/kg-day)	Uncertainty Factors: Non-sensitive to sensitive	Subchronic to Chronic UF	NOAEL to LOAEL UF	Adjusted LOAEL-Equivalent TRV (mg/kg-day)	Sample & Arenal 1999 Mammalian Allometric Scaling	Source of TRV	Source/TRV Provided by:
Metals:													
Aluminum	Mouse	Reproduction	Chronic	LOAEL	0.03	19.3	-	-	-	19.3	0.94	Ondreick et al. 1966	Rocketdyne, 2003
Antimony	Rat	Longevity, survivorship, histopathology	Chronic	LOAEL	0.209	0.6	-	-	-	0.6	0.94	Schroeder et al. 1970	HERD VAFB Memo 4/2002
Arsenic	Rat	Reproduction	Chronic	EL	0.25	4.7	-	-	-	4.7	0.874	EFA West, 1998	EFA West, 1998
Barium	Rat	growth, development	Chronic	LOAEL	0.35	19.8	-	-	-	19.8	0.746	Borzelleca et al. 1988	U.S. Air Force, 2004
Beryllium	Rat	Longevity (sensitive life stage- newborns)	Chronic	NOAEL	0.35	0.66	-	-	1/5	3.3	0.94	Schroeder and Mitchner, 1975	U.S. Air Force, 2004
Boron	Rat	Reproduction	Chronic	LOAEL	0.35	93.6	-	-	-	93.6	0.94	Weir and Fisher, 1972	Sample et al., 1996
Cadmium	Mouse	Reproduction	Chronic	EL	0.03141	2.64	-	-	-	2.64	0.893	EFA West, 1998	EFA West, 1998
Chromium, hexavalent	Rat	Mortality	Chronic	LOAEL	0.35	13.14	**	-	-	13.14	0.94	Steven et al., 1976	Sample et al., 1996
Chromium, Total	Rat	Growth, organ weight, blood chemistry	Chronic	NOAEL	0.35	1468	-	-	1/5	7340	0.94	IRIS (Ivankovic and Preussman, 1975)	Rocketdyne, 2003
Cobalt	Rat	Reproduction (decreased pup growth)	Chronic	EL	0.35	20	-	-	-	20	0.94	EFA West, 1998	EFA West, 1998
Copper	Mouse	H2O consumption, body weight, mortality	Chronic	EL	0.0247	631.58	*	-	-	631.58	0.94	EFA West, 1998	EFA West, 1998
Cyanide	Rat	Reproduction	Chronic	NOAEL	0.273	68.7	-	-	1/5	343.5	0.94	Sample et al. 1996	Rocketdyne, 2003
Lead	Mouse	Body weight, liver and kidney weight	Chronic	EL	0.0187	240.64	-	-	-	240.65	0.94	EFA West, 1998	EFA West, 1998
Manganese	Mouse	Reproductive Organ Toxicity	Chronic	EL	0.0297	159.09	-	-	-	159.09	0.94	EFA West, 1998	EFA West, 1998
Mercury	Rat	Development	Chronic	EL	0.428	4	-	-	-	4	0.983	EFA West, 1998	EFA West, 1998
Molybdenum	Mouse	Reproduction	Chronic	LOAEL	0.03	2.6	-	-	-	2.6	0.94	Schroeder and Mitchner, 1971	Rocketdyne, 2003
Nickel	Rat	Reproduction	Chronic	EL	0.2486	31.6	-	-	-	31.6	0.94	EFA West, 1998	EFA West, 1998
Selenium	Mouse	Reproduction	Chronic	EL	0.0246	1.21	-	-	-	1.21	0.94	EFA West, 1998	EFA West, 1998
Silver	Mouse	Hyperactivity	Subchronic	LOAEL	0.024	3.75	-	2	-	1.875	0.94	EPA Region 6	Rocketdyne, 2003
Strontium	Rat	reduced bone calcification	Chronic	LOAEL	0.06	633	-	-	-	633	0.94	Marie et al. 1985	IRIS, ATSDR
Thallium	Rat	Hair loss	Chronic	EL	0.065	1.43	*	-	-	1.43	0.808	EFA West, 1998	EFA West, 1998
Titanium	Rat	Reproduction, fertility	Chronic	LOAEL	0.35	0.746	-	-	-	0.746	0.94	Schroeder and Mitchner, 1971	Ecotox, WHO 1982
Vanadium	Rat	Reproduction	Chronic	LOAEL	0.26	2.1	-	-	-	2.1	0.94	Domingo et al. 1986	Rocketdyne, 2003
Zinc	Rat	Fetal weight, fetal resorptions	Chronic	EL	0.175	411.43	-	-	-	411.43	0.851	EFA West, 1998	EFA West, 1998
Organics:													
1,1,1-Trichloroethane	Mouse	Developmental	Chronic	NOAEL	0.035	1000	-	-	1/5	5000	0.648	Lane et al., 1982	U.S. Air Force, 2004
1,1,2-Trichloroethane	Mouse	Hematology	Subchronic	LOAEL	0.03	44	-	2	-	22	0.94	IRIS (Sanders et al., 1985)	Rocketdyne, 2003
1,1-Dichloroethene	Dog	Organ toxicity, mortality	Chronic	NOAEL	14	2.5	-	-	1/5	12.5	1.539	Sample et al. 1996	Rocketdyne, 2003
1,1-Dichloropropene	Rat	Decreased body weight, changes in organ weights	Chronic	NOAEL	0.35	15	-	-	-	15	0.94	Haut et al. 1996 (1,3-Dichloropropene)	IRIS
1,2,3,4,6,7,8-HpCDD	Rat	growth, organ toxicity, blood chemistry	Chronic	LOAEL	0.35	0.001	-	-	-	0.001	0.537	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
1,2,3,6,7,8-HxCDD	Rat	growth, organ toxicity, blood chemistry	Chronic	LOAEL	0.35	0.0001	-	-	-	0.0001	0.94	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
1,2,3,4,6,7,8-HpCDF	Rat	growth, organ toxicity, blood chemistry	Chronic	LOAEL	0.35	0.001	-	-	-	0.001	0.94	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
1,2,3,4,7,8,9-HpCDF	Rat	growth, organ toxicity, blood chemistry	Chronic	LOAEL	0.35	0.001	-	-	-	0.001	0.94	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
1,2,3,4,7,8-HxCDF	Rat	growth, organ toxicity, blood chemistry	Chronic	LOAEL	0.35	0.0001	-	-	-	0.0001	0.94	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
1,2,3,6,7,8-HxCDF	Rat	growth, organ toxicity, blood chemistry	Chronic	LOAEL	0.35	0.0001	-	-	-	0.0001	0.94	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
1,2,3,7,8-PeCDF	Rat	growth, organ toxicity, blood chemistry	Chronic	LOAEL	0.35	0.0002	-	-	-	0.0002	0.94	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
1,2,3-Trichlorobenzene	Rat	Reproduction	Chronic	LOAEL	0.35	53.6	-	-	-	53.6	0.94	IRIS (1,2,4-Trichlorobenzene)	Rocketdyne, 2003
1,2,4-Trichlorobenzene	Rat	Reproduction	Chronic	LOAEL	0.35	53.6	-	-	-	53.6	0.94	IRIS (Robinson et al., 1981)	Rocketdyne, 2003
1,2,4-Trimethylbenzene	Rat	Liver to body weight ratio	Subchronic	LOAEL	0.35	150	-	2	-	75	0.94	Xylenes (total) as surrogate	Tetra Tech, 2002
1,2-Dibromo-3-chloropropane	Rat	Growth, histology	Chronic	LOAEL	0.35	5.1	-	-	-	5.1	0.94	IRIS (1,3-Dichloropropene)	Rocketdyne, 2003
1,2-Dichlorobenzene	Rat	Organ toxicity	Chronic	LOAEL	0.35	178.6	-	-	-	178.6	0.94	IRIS (NTP, 1985)	Rocketdyne, 2003
1,2-Dichloroethane	Mouse	Reproduction	Chronic	NOAEL	0.035	50	-	-	1/5	250	0.835	Lane et al., 1982	U.S. Air Force, 2004
1,2-Dichloroethene	Rat	Histopathology, reproductive organs	Subchronic	NOAEL	0.25	872	-	2	1/5	4360	0.94	McCauley et al. 1990	U.S. Air Force, 2004
1,3,5-Trimethylbenzene	Rat	Liver to body weight ratio	Subchronic	LOAEL	0.35	150	-	2	-	75	0.94	Xylenes (total) as surrogate	Tetra Tech, 2002
1,3-Dichlorobenzene	Rat	Body weight gain	Subchronic	LOAEL	0.35	107	10	2	-	5.35	0.94	ATSDR (1,4-Dichlorobenzene)	Rocketdyne, 2003
1,4-Dichlorobenzene	Rat	Body weight gain	Subchronic	LOAEL	0.35	107	10	2	-	5.35	0.94	Lake et al. 1997	Rocketdyne, 2003
2,3,7,8-TCDD	Rat	growth, organ toxicity, blood chemistry	Chronic	LOAEL	0.35	0.00001	-	-	-	0.00001	0.537	Sample et al. 1996	Rocketdyne, 2003
2,3,4,6,7,8-HxCDF	Rat	growth, organ toxicity, blood chemistry	Chronic	LOAEL	0.35	0.0001	-	-	-	0.0001	0.94	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
2,3,4,7,8-PeCDF	Rat	growth, organ toxicity, blood chemistry	Chronic	LOAEL	0.35	0.00002	-	-	-	0.00002	0.94	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
2,3,7,8-TCDF	Rat	growth, organ toxicity, blood chemistry	Chronic	LOAEL	0.35	0.0001	-	-	-	0.0001	0.94	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
2-Butanone (MEK)	Rat	Reproduction	Chronic	LOAEL	0.35	3122	-	-	-	3122	0.94	IRIS (Cox et al., 1975)	Rocketdyne, 2003
2-Hexanone	Rat	-- Not available --	Subchronic	LOAEL	0.35	570	10	2	-	28.5	0.94	HEAST FY 1997 (Hexane)	Rocketdyne, 2003
2-Methylnaphthalene	Rat	Body weight gain	Chronic	EL	0.2702	150	*	-	-	150	0.94	EFA West, 1998 (Naphthalene)	Rocketdyne, 2003
4,4'-DDD	Rat	Reproduction	Chronic	EL	0.32	16	-	-	-	16	1.268	EFA West, 1998	EFA West, 1998
4,4'-DDE	Rat	Reproduction	Chronic	EL	0.32	16	-	-	-	16	1.268	EFA West, 1998	EFA West, 1998
4,4'-DDT	Rat	Reproduction	Chronic	EL	0.32	16	-	-	-	16	1.268	EFA West, 1998	EFA West, 1998
4-Methyl-2-pentanone (MIBK)	Rat	-- Not available --	Subchronic	LOAEL	0.35	570	10	2	-	28.5	0.94	HEAST FY 1997 (Hexane)	Rocketdyne, 2003
4-Methylphenol	Rat	Decreased body and organ weights, food consumption	Subchronic	LOAEL	0.35	150	-	2	-	75	0.94	U.S. EPA 1986	IRIS
Acenaphthylene	Mouse	Growth, organ toxicity	Subchronic	LOAEL	0.03	350	-	2	-	175	0.94	IRIS (Acenaphthene - U.S. EPA, 1989a)	Rocketdyne, 2003
Acetone	Rat	Kidney and liver toxicity	Chronic	LOAEL	0.35	50	-	-	-	50	1.128	Sample et al. 1996	Rocketdyne, 2003
alpha-Chlordane	Mouse	Liver toxicity	Chronic	LOAEL	0.03	0.6	-	-	-	0.6	0.829	Khasawinah and Grutsch 1989 (Chlordane)	Rocketdyne, 2003
Anthracene	Mouse	Growth, histology	Subchronic	NOAEL	0.03	1000	-	2	1/5	2500	0.94	IRIS (U.S. EPA 1989)	Rocketdyne, 2003

	Primary Study Information:						Uncertainty Factors						
Chemical:	**Test Species**	**Observed Effect**	**Chronic/ Subchronic**	**Effect level**	**Body Weight (kg)**	**Non-adjusted TRV (mg/kg-day)**	**Non-sensitive to sensitive**	**Subchronic to Chronic UF**	**NOAEL to LOAEL UF**	**Adjusted LOAEL-Equivalent TRV (mg/kg-day)**	**Sample & Arenal 1999 Mammalian Allometric Scaling**	**Source of TRV**	**Source/TRV Provided by:**
Aroclor 1248[c]	Mouse	Litter size and survival	Chronic	EL	0.02285	1.28	-	-	-	1.28	0.94	EFA West, 1998	EFA West, 1998
Aroclor 1254[c]	Mouse	Litter size and survival	Chronic	EL	1.02285	1.28	-	-	-	1.28	0.94	EFA West, 1998	EFA West, 1998
Aroclor 1260[c]	Mouse	Litter size and survival	Chronic	EL	2.02285	1.28	-	-	-	1.28	0.94	EFA West, 1998	EFA West, 1998
Benzene	Mouse	Erythrocyte and lymphocyte counts	Subchronic	LOAEL	0.03	8	-	2	-	4	0.818	Tech Memo	Tetra Tech, 2002
Benzo(a)anthracene	Mouse	Pulmonary adenoma	Chronic	EL	0.0305	32.79	-	-	-	32.79	0.94	EFA West, 1998 (benzo(a)pyrene)	EFA West, 1998
Benzo(a)pyrene	Mouse	Pulmonary adenoma	Chronic	EL	0.0305	32.79	-	-	-	32.79	0.94	EFA West, 1998	EFA West, 1998
Benzo(b)fluoranthene	Mouse	Pulmonary adenoma	Chronic	EL	0.0305	32.79	-	-	-	32.79	0.94	EFA West, 1998 (benzo(a)pyrene)	EFA West, 1998
Benzo(g,h,i)perylene	Mouse	Pulmonary adenoma	Chronic	EL	0.0305	32.79	-	-	-	32.79	0.94	EFA West, 1998 (benzo(a)pyrene)	EFA West, 1998
Benzo(k)fluoranthene	Mouse	Pulmonary adenoma	Chronic	EL	0.0305	32.79	-	-	-	32.79	0.94	EFA West, 1998 (benzo(a)pyrene)	EFA West, 1998
Bis (2-ethylhexyl) Pthalate (BEHP)	Mouse	Reproduction	Chronic	LOAEL	0.03	183.3	-	-	-	183.3	1.531	Lamb et al., 1987	Sample et al., 1996
Bromodichloromethane	Mouse	Kidney toxicity	Chronic	LOAEL	0.03	17.9	-	-	-	17.9	0.94	IRIS (NTP 1986)	Rocketdyne, 2003
Bromoform	Rat	Organ toxicity	Subchronic	LOAEL	0.35	35.7	-	2	-	17.9	0.94	IRIS (NTP 1989)	Rocketdyne, 2003
Carbon tetrachloride	Rat	Liver toxicity	Subchronic	LOAEL	0.35	7.1	-	2	-	3.55	0.703	IRIS (Bruckner et al., 1986)	Rocketdyne, 2003
Chloroform	Dog	Liver toxicity	Chronic	LOAEL	14	1	-	-	-	1	1.192	IRIS (Heywood et al., 1979)	Rocketdyne, 2003
Chrysene	Mouse	Pulmonary adenoma	Chronic	EL	0.0305	32.79	-	-	-	32.79	0.94	EFA West, 1998 (benzo(a)pyrene)	EFA West, 1998
Dalapon	Rat	Kidney-to-body weight ratio	Chronic	LOAEL	0.35	50	-	-	-	50	0.94	Paytner et al. 1960	IRIS
Dibenzo(a,h)anthracene	Mouse	Pulmonary adenoma	Chronic	EL	0.0305	32.79	-	-	-	32.79	0.94	EFA West, 1998 (benzo(a)pyrene)	EFA West, 1998
Dibromochloromethane	Rat	Hepatic lesions	Subchronic	LOAEL	0.35	42.9	-	2	-	21.45	0.94	IRIS (NTP 1985)	Rocketdyne, 2003
Dichlorodifluoromethane (Freon 12)	Rat	Body weight (sensitive life stage), hematology or histopa	Chronic	LOAEL	0.35	150	-	-	-	150	0.94	IRIS (Sherman, 1974)	
Dieldrin	Rat	Reproduction	Chronic	LOAEL	0.35	0.2	-	-	-	0.2	0.94	Treon and Cleveland 1955	Rocketdyne, 2003
Diethyl phthalate (DEP)	Rat	Decreased growth and food intake, and altered organ we	Subchronic	LOAEL	0.35	3160	-	2	-	1580	0.716	IRIS (Brown et al., 1978)	
di-n-butyl phthalate	Rat	Reproduction (decreased pup weight)	Chronic	LOAEL	0.35	250	-	-	-	250	1.345	Killenger et al. 1988 (ATSDR)	Rocketdyne, 2003
Endrin	Dog (Beag	Convulsions, liver weight, liver histolopathological effects	Chronic	LOAEL	12.7	0.05	-	-	-	0.05	0.967	Velsicol Chemical Corporation. 1969	IRIS
Endrin aldehyde	Dog (Beag	Convulsions, liver weight, liver histolopathological effects	Chronic	LOAEL	12.7	0.05	-	-	-	0.05	0.967	Velsicol Chemical Corporation. 1969	IRIS
Ethylbenzene	Mouse	Rotorod performance	Subchronic	LOAEL	0.03	3.2	-	2	-	1.6	0.94	Tech Memo (Toluene)	Tetra Tech, 2002
Fluoranthene	Mouse	Liver and kidney toxicity, hematology	Subchronic	LOAEL	0.03	250	-	2	-	125	0.94	IRIS (U.S. EPA, 1988)	Rocketdyne, 2003
Fluorene	Mouse	Hematology	Subchronic	LOAEL	0.03	250	-	2	-	125	0.94	IRIS (U.S. EPA, 1988)	Rocketdyne, 2003
gamma-Chlordane	Mouse	Liver toxicity	Chronic	LOAEL	0.03	0.6	-	-	-	0.6	0.829	Khasawinah and Grutsch 1989 (Chlordane)	Rocketdyne, 2003
HpCDD (total)	Rat	growth, organ toxicity, blood chemistry	Chronic	LOAEL	0.35	0.001	-	-	-	0.001	0.94	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
HxCDD (Total)	Rat	growth, organ toxicity, blood chemistry	Chronic	LOAEL	0.35	0.0001	-	-	-	0.0001	0.94	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
HxCDF (total)	Rat	growth, organ toxicity, blood chemistry	Chronic	LOAEL	0.35	0.0001	-	-	-	0.0001	0.94	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
Indeno(1,2,3-cd)pyrene	Mouse	Pulmonary adenoma	Chronic	EL	0.0305	32.79	-	-	-	32.79	0.94	EFA West, 1998 (benzo(a)pyrene)	EFA West, 1998
Isopropylbenzene (cumene)	Mouse	Rotorod performance	Subchronic	LOAEL	0.03	3.2	-	2	-	1.6	0.94	Tech Memo (Ethylbenzene)	Tetra Tech, 2002
m,p-Xylenes	Rat	Liver to body weight ratio	Subchronic	LOAEL	0.35	150	-	2	-	75	0.94	Xylenes (total) as surrogate	Tetra Tech, 2002
Methanol	Rat	Mortality, blood chemistry	Subchronic	LOAEL	0.35	2500	-	2	-	1250	0.94	Sample et al. 1996	Rocketdyne, 2003
Methoxychlor	Rat	Reproductive effects in pups of treated dams	Chronic	EL	0.35	50	-	-	-	50	1.224	Gray et al. 1989	EFA West, 1998
Methylene Chloride	Rat	Liver histology	Chronic	LOAEL	0.35	50	-	-	-	50	0.94	Sample et al. 1996	Rocketdyne, 2003
Naphthalene	Rat	Body weight gain	Chronic	EL	0.2702	150	*	-	-	150	0.94	EFA West, 1998	EFA West, 1998
n-Butylbenzene	Mouse	Rotorod performance	Subchronic	LOAEL	0.03	3.2	-	2	-	1.6	0.94	Tech Memo (Ethylbenzene)	Tetra Tech, 2002
n-Propylbenzene	Mouse	Rotorod performance	Subchronic	LOAEL	0.03	3.2	-	2	-	1.6	0.94	Tech Memo (Ethylbenzene)	Tetra Tech, 2002
OCDD	Rat	growth, organ toxicity, blood chemistry	Chronic	LOAEL	0.35	0.1	-	-	-	0.1	0.537	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
OCDF	Rat	growth, organ toxicity, blood chemistry	Chronic	LOAEL	0.35	0.1	-	-	-	0.1	0.537	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
o-Xylene	Rat	Liver to body weight ratio	Subchronic	LOAEL	0.35	150	-	2	-	75	0.94	Xylenes (total) as surrogate	Tetra Tech, 2002
p-cymene (p-isopropyltoluene)	Rat	Liver to body weight ratio	Subchronic	LOAEL	0.35	150	-	2	-	75	0.94	Xylenes (total) as surrogate	Tetra Tech, 2002
PeCDF (total)	Rat	growth, organ toxicity, blood chemistry	Chronic	LOAEL	0.35	0.00002	-	-	-	0.00002	0.94	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
Phenanthrene	Mouse	Kidney toxicity	Subchronic	LOAEL	0.03	125	-	2	-	62.5	0.94	IRIS (Pyrene)	Rocketdyne, 2003
Perchlorate[d]	Rat	Reproduction	Chronic	NOAEL	0.35	30	-	-	1/5	150	0.94	York et al. 2001	U.S. EPA 2002b
Perchlorate[e]	Rat	Thyroid weight, colloid depletion, hypertrophy,	Chronic	LOAEL	0.35	0.1	-	-	-	0.1	0.94	Argus Research Laboratories, 1998 a,b,c	U.S. EPA 2002b
Pyrene	Mouse	Kidney toxicity	Subchronic	LOAEL	0.03	125	-	2	-	62.5	0.94	IRIS (U.S. EPA, 1989b)	Rocketdyne, 2003
sec-butylbenzene	Mouse	Rotorod performance	Subchronic	LOAEL	0.03	3.2	-	2	-	1.6	0.94	Tech Memo (Ethylbenzene)	Tetra Tech, 2002
TCDF (Total)	Rat	growth, organ toxicity, blood chemistry	Chronic	LOAEL	0.35	0.0001	-	-	-	0.0001	0.94	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
Tetrachloroethene	Mouse	Locomotion and total activity	Chronic	LOAEL	0.03	5	-	-	-	5	1.05	Tech Memo	Tetra Tech, 2002
Toluene	Mouse	Rotorod performance	Subchronic	LOAEL	0.03	3.2	-	2	-	1.6	0.94	Tech Memo	Tetra Tech, 2002
Trichloroethene	Mouse	Hepatotoxicity, relative liver weight	Chronic	LOAEL	0.03	7	-	-	-	7	1.111	Tech Memo	Tetra Tech, 2002
Xylenes (total)	Rat	Liver to body weight ratio	Subchronic	LOAEL	0.35	150	-	2	-	75	0.94	Tech Memo	Tetra Tech, 2002

Notes:

a - If the body weight of the receptor differs from the body weight of the test animal, an allometric scaling factor is applied (Sample and Arenal, 1999): $TRV_{adjusted} = TRV_{unadjusted} * (BW_{TestSpecies}/BW_{Receptor})\text{^}(1\text{-Scaling Factor})$

b - Taxonomic Uncertainty factors are applied to the TRVs as follows: UF of 5 is applied to the kangaroo rats, and a UF of 10 is applied to the Kit Fox (USGS 2001).

c - Total PCBs used as surrogate for Arochlor benchmark.

d, e - Two different TRVs were selected for perchlorate to evaluate the full range of toxic effects.

* - No additional UF is necessary because this is a Navy BTAG number.

** - No sensitive endpoint UF is required because the effect occurred at the lowest effect level

IRIS refers to the on-line Integrated Risk Information System, U.S. EPA 2004a

Ecotox refers to the on-line Ecotox database, U.S. EPA 2004b

Chemical:	Test Species	Endpoint	Chronic/ Subchronic	Effect level	Body Weight (kg)	Non-adjusted TRV (mg/kg-day)	Non-sensitive to sensitive	Subchronic to Chronic UF	LOAEL to NOAEL UF	Adjusted NOAEL-Equivalent TRV (mg/kg-day)	Sample & Arenal 1999 Mammalian Allometric Scaling Factor	Source of TRV	Source/TRV Provided by:
	Primary Study Information:						**Uncertainty Factors**						
Metals:													
Aluminum	Ringed Dove	Reproduction	Chronic	NOAEL	0.155	109.7	-	-	-	109.7	1.2	Carriere et al. 1986	Rocketdyne, 2003
Arsenic	Mallard	Reproduction, development	Chronic	NOAEL	1.172	5.5	-	-	-	5.5	1.2	EFA West, 1998	EFA West, 1998
Barium	Chicken	Mortality, growth (sensitive life stage)	Subchronic	NOAEL	0.121	208.26	10	2	-	10.4	1.2	Johnson et al. 1960	Rocketdyne, 2003
Boron	Mallard	Reproduction	Chronic	NOAEL	1	28.8	-	-	-	28.8	1.2	Smith and Anders, 1989	Sample et al. 1996
Cadmium	Mallard	Kidney degeneration	Chronic	NOAEL	0.7985	0.08	-	-	-	0.08	1.2	EFA West, 1998	EFA West, 1998
Chromium, Total	American black duck	Pathology, growth	Chronic	NOAEL	1.25	1	-	-	-	1	1.2	Haseltine et al. 1985	U.S. Air Force, 2004
Copper	Broiler	Weight gain	Subchronic	NOAEL	0.639	22.99	*	10**	-	2.3	1.2	EFA West, 1998	EFA West, 1998
Lead	Japanese Quail	Egg production, male organ weights	Chronic	LOAEL	0.084	0.14	*	-	10**	0.014	1.2	EFA West, 1998	EFA West, 1998
Manganese	Japanese Qauil	Motor development, behavior	Chronic	LOAEL	0.1965	776	*	-	10**	77.6	1.2	EFA West, 1998	EFA West, 1998
Mercury	Mallard	Reproductive effects	Chronic	NOAEL	1	0.039	-	-	-	0.039	1.2	EFA West, 1998	EFA West, 1998
Molybdenum	Chicken	Egg counts, embryo viability	Chronic	LOAEL	0.8	35.3	-	-	5	7.1	1.2	Lepore and Miller 1965	Rocketdyne, 2003
Nickel	Mallard	Tremors and edema in toe and leg	Subchronic	NOAEL	0.61375	13.8	*	10**	-	1.38	1.2	EFA West, 1998	EFA West, 1998
Selenium	Mallard	Hatchling count, body weight, survival	Chronic	NOAEL	1.1077	0.23	-	-	-	0.23	1.2	EFA West, 1998	EFA West, 1998
Vanadium	Chicken	Egg Production	Chronic	NOAEL	1.53	2.3	-	-	-	2.3	1.2	Kubena and Phillips 1982	U.S. Air Force, 2004
Zinc	Mallard	Body weight, organ weights	Chronic	LOAEL	0.955	172	*	-	10**	17.2	1.2	EFA West, 1998	EFA West, 1998
Organics:													
1,2,3,4,6,7,8-HpCDD	Chicken	Mortality, chick edema	Chronic	NOAEL	0.203	0.01	-	-	-	0.01	1.2	TEF from Van den Berg et al. 1998	Rocketdyne, 2003
1,2,3,6,7,8-HxCDD	Chicken	Mortality, chick edema	Chronic	NOAEL	0.203	0.001	-	-	-	0.001	1.2	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
1,2,3,4,6,7,8-HpCDF	Chicken	Mortality, chick edema	Chronic	NOAEL	0.203	0.001	-	-	-	0.001	1.2	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
1,2,3,4,7,8,9-HpCDF	Chicken	Mortality, chick edema	Chronic	NOAEL	0.203	0.001	-	-	-	0.001	1.2	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
1,2,3,4,7,8-HxCDF	Chicken	Mortality, chick edema	Chronic	NOAEL	0.203	0.0001	-	-	-	0.0001	1.2	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
1,2,3,6,7,8-HxCDF	Chicken	Mortality, chick edema	Chronic	NOAEL	0.203	0.0001	-	-	-	0.0001	1.2	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
1,2,3,7,8-PeCDF	Chicken	Mortality, chick edema	Chronic	NOAEL	0.203	0.0001	-	-	-	0.0001	1.2	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
1,2-Dichloroethane	Chicken	Reduced egg weight, egg production	Chronic	NOAEL	1.6	16	-	-	-	16	1.2	Alumot et al. 1976	U.S. Air Force, 2004
2,3,7,8-TCDD	Chicken	Mortality, chick edema	Chronic	NOAEL	0.203	0.00001	-	-	-	0.00001	1.2	Schwetz et al. 1973	U.S. Air Force, 2004
2,3,4,6,7,8-HxCDF	Chicken	Mortality, chick edema	Chronic	NOAEL	0.203	0.0001	-	-	-	0.0001	1.2	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
2,3,4,7,8-PeCDF	Chicken	Mortality, chick edema	Chronic	NOAEL	0.203	0.00001	-	-	-	0.00001	1.2	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
2,3,7,8-TCDF	Chicken	Mortality, chick edema	Chronic	NOAEL	0.121	0.00001	-	-	-	0.00001	1.2	McKinney et al. 1976	U.S. Air Force, 2004
4,4'-DDD	Pelican	Reproductive effects	Chronic	NOAEL	3.5	0.009	-	-	-	0.009	1.2	EFA West, 1998	EFA West, 1998
4,4'-DDE	Pelican	Reproductive effects	Chronic	NOAEL	3.5	0.009	-	-	-	0.009	1.2	EFA West, 1998	EFA West, 1998
4,4'-DDT	Pelican	Reproductive effects	Chronic	NOAEL	3.5	0.009	-	-	-	0.009	1.2	EFA West, 1998	EFA West, 1998
4-methylphenol	Red-winged Blackbird	Mortality	Acute	LD50	0.04	96	-	100 *(LD_{50} to NOAEL)*		0.96	1.2	Schafer et al. 1983	Rocketdyne, 2003
Acenaphthylene	Red-Winged Blackbird	Mortality	Acute	LD50	0.04	101	-	100 *(LD_{50} to NOAEL)*		1.01	1.2	Schafer et al. 1983 (Acenaphthene as surrogate)	Rocketdyne, 2003
Acetone	Japanese Quail	Survival / mortality	Subchronic	NOAEL	0.043	10483	10	2	-	524.15	1.2	Hill and Camardese 1986	U.S. Air Force, 2004
alpha-Chlordane	Red-Winged Blackbird	Mortality	Subchronic	NOAEL	0.064	2.2	10	2	-	0.11	2.492	Stickel et al. 1983 (Chlordane)	U.S. Air Force, 2004
Anthracene	Red-winged Blackbird	Mortality	Acute	LD50	0.04	111	-	100 *(LD_{50} to NOAEL)*		1.1	1.2	Schafer et al. 1983	Rocketdyne, 2003
Aroclor 1248	Chicken	Egg production	Chronic	LOAEL	0.08	0.88	*	-	10**	0.088	1.2	EFA West, 1998	EFA West, 1998
Aroclor 1254	Chicken	Egg production	Chronic	LOAEL	0.08	0.88	*	-	10**	0.088	1.2	EFA West, 1998	EFA West, 1998
Aroclor 1260	Chicken	Egg production	Chronic	LOAEL	0.08	0.88	*	-	10**	0.088	1.2	EFA West, 1998	EFA West, 1998
Dieldrin	Mallard	Some mortality	Subchronic	LOAEL	1	5	10	-	10	0.05	1.201	Hudson et al. 1984	U.S. Air Force, 2004
di-n-butyl phthalate	Ringed Dove	Reproduction	Chronic	LOAEL	0.155	1.1	-	-	5	0.22	1.2	Peakall et al. 1974	Rocketdyne, 2003
Endrin	Screech Owl	Reproduction	Chronic	NOAEL	0.181	0.01035	-	-	-	0.01	1.25	Fleming et al. 1982	Rocketdyne, 2003
Endrin aldehyde	Screech Owl	Reproduction	Chronic	NOAEL	0.181	0.01035	-	-	-	0.01	1.25	Fleming et al. 1982	Rocketdyne, 2003
Fluorene	Red-Winged Blackbird	Mortality	Chronic	LD50	0.04	101	-	100 *(LD_{50} to NOAEL)*		1.01	1.2	Schafer et al. 1983	Rocketdyne, 2003
gamma-Chlordane	Red-Winged Blackbird	Mortality	Subchronic	NOAEL	0.064	2.2	10	2	-	0.11	2.492	Stickel et al. 1983 (Chlordane)	U.S. Air Force, 2004
HpCDD (total)	Chicken	Mortality, chick edema	Chronic	NOAEL	0.203	0.01	-	-	-	0.01	1.2	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
HxCDD (Total)	Chicken	Mortality, chick edema	Chronic	NOAEL	0.203	0.0001	-	-	-	0.0001	1.2	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
HxCDF (total)	Chicken	Mortality, chick edema	Chronic	NOAEL	0.203	0.0001	-	-	-	0.0001	1.2	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
Methoxychlor	Japanese Quail	Mortality	Subchronic	NOAEL	0.043	1310.5	10	2	-	65.53	1.2	Hill et al, 1975	ECOTOX
OCDD	Chicken	Mortality, chick edema	Chronic	NOAEL	0.203	0.1	-	-	-	0.1	1.2	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
OCDF	Chicken	Mortality, chick edema	Chronic	NOAEL	0.203	0.1	-	-	-	0.1	1.2	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
PeCDF (Total)	Chicken	Mortality, chick edema	Chronic	NOAEL	0.203	0.00001	-	-	-	0.00001	1.2	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
Phenanthrene	Red-Winged Blackbird	Mortality	Chronic	LD50	0.04	113	-	100 *(LD_{50} to NOAEL)*		1.13	1.2	Schafer et al. 1983	Rocketdyne, 2003
Perchlorate[b]	Bobwhite Quail	Developmental - femur length	Chronic	NOAEL	0.08	154	-	-	-	154	1.2	McNabb et al. 2004	-
Perchlorate[c]	Bobwhite Quail	Thyroid weight	Chronic	NOAEL	0.08	77	-	-	-	77	1.2	McNabb et al. 2004	-
TCDF (Total)	Chicken	Mortality, chick edema	Chronic	NOAEL	0.203	0.00001	-	-	-	0.00001	1.2	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne

Chemical:	Test Species	Endpoint	Chronic/ Subchronic	Effect level	Body Weight (kg)	Non-adjusted TRV (mg/kg-day)	Non-sensitive to sensitive	Subchronic to Chronic UF	NOAEL to LOAEL UF	Adjusted LOAEL-Equivalent TRV (mg/kg-day)	Sample & Arenal 1999 Mammalian Allometric Scaling Factor	Source of TRV	Source/TRV Provided by:
	Primary Study Information:						Uncertainty Factors						
Metals:													
Aluminum	Ringed Dove	Reproduction	Chronic	NOAEL	0.155	109.7	-	-	1/5	548.5	1.2	Carriere et al. 1986	Rocketdyne, 2003
Arsenic	Mallard	Reproduction, development	Chronic	EL	1.172	22.01	-	-	-	22.01	1.2	EFA West, 1998	EFA West, 1998
Barium	Chicken	Mortality, growth (sensitive life stage)	Subchronic	LOAEL	0.121	416.53	10	2	-	20.8	1.2	Johnson et al. 1960	Rocketdyne, 2003
Boron	Mallard	Reproduction	Chronic	LOAEL	1	100	-	-	-	100	1.2	Smith and Anders, 1989	Sample et al 1996
Cadmium	Japanese Quail	Organ weights, histopathology	Chronic	EL	0.084	10.43	-	-	-	10.43	1.2	EFA West, 1998	EFA West, 1998
Chromium, total	American black duck	Pathology, growth	Chronic	LOAEL	1.25	5	-	-	-	5	1.2	Haseltine et al. 1986	U.S. Air Force, 2004
Copper	Cobb broiler	Gizzard weight, erosion	Chronic	EL	0.409	52.26	-	-	-	52.26	1.2	EFA West, 1998	EFA West, 1998
Lead	Chicken	Egg production	Chronic	EL	0.8	8.75	-	-	-	8.75	1.2	EFA West, 1998	EFA West, 1998
Manganese	Japanese Qauil	Motor development, behavior	Chronic	EL	0.1965	776	-	-	-	776	1.2	EFA West, 1998	EFA West, 1998
Mercury	Mallard	Reproductive effects	Chronic	EL	1	0.18	-	-	-	0.18	1.2	EFA West, 1998	EFA West, 1998
Molybdenum	Chicken	Egg counts, embryo viability	Chronic	LOAEL	0.8	35.3	-	-	-	35.3	1.2	Lepore and Miller 1965	Rocketdyne, 2003
Nickel	Mallard	Length:weight ratio of humerus	Chronic	EL	0.58	55.16	-	-	-	55.16	1.2	EFA West, 1998	EFA West, 1998
Selenium	Mallard	Hatchling success	Chronic	EL	1.1077	0.93	-	-	-	0.93	1.2	EFA West, 1998	EFA West, 1998
Vanadium	Chicken	Egg production	Chronic	LOAEL	1.53	4.6	-	-	-	4.6	1.2	Kubena and Phillips 1982	U.S. Air Force, 2004
Zinc	Mallard	Body weight, organ weights	Chronic	EL	0.955	172	-	-	-	172	1.2	EFA West, 1998	EFA West, 1998
Organics:													
1,2,3,4,6,7,8-	Chicken	Mortality, chick edema	Chronic	LOAEL	0.203	0.1	-	-	-	0.1	1.2	TEF from Van den Berg et al. 1998	Rocketdyne, 2003
1,2,3,6,7,8-HxCDD	Chicken	Mortality, chick edema	Chronic	LOAEL	0.203	0.01	-	-	-	0.01	1.2	TEF from Van den Berg et al. 1998	Rocketdyne, 2003
1,2,3,4,6,7,8-	Chicken	Mortality, chick edema	Chronic	LOAEL	0.203	0.01	-	-	-	0.01	1.2	TEF from Van den Berg et al. 1998	Rocketdyne, 2003
1,2,3,4,7,8,9-	Chicken	Mortality, chick edema	Chronic	LOAEL	0.203	0.01	-	-	-	0.01	1.2	TEF from Van den Berg et al. 1998	Rocketdyne, 2003
1,2,3,4,7,8-HxCDF	Chicken	Mortality, chick edema	Chronic	LOAEL	0.203	0.001	-	-	-	0.001	1.2	TEF from Van den Berg et al. 1998	Rocketdyne, 2003
1,2,3,6,7,8-HxCDF	Chicken	Mortality, chick edema	Chronic	LOAEL	0.203	0.001	-	-	-	0.001	1.2	TEF from Van den Berg et al. 1998	Rocketdyne, 2003
1,2,3,7,8-PeCDF	Chicken	Mortality, chick edema	Chronic	LOAEL	0.203	0.001	-	-	-	0.001	1.2	TEF from Van den Berg et al. 1998	Rocketdyne, 2003
1,2-Dichloroethane	Chicken	Reduced egg weight	Chronic	LOAEL	1.6	32	-	-	-	32	1.2	Alumot et al. 1976	U.S. Air Force, 2004
2,3,7,8-TCDD	Chicken	Mortality, chick edema	Chronic	LOAEL	0.203	0.0001	-	-	-	0.0001	1.2	Schwetz et al. 1973	U.S. Air Force, 2004
2,3,4,6,7,8-HxCDF	Chicken	Mortality, chick edema	Chronic	LOAEL	0.203	0.001	-	-	-	0.001	1.2	TEF from Van den Berg et al. 1998	Rocketdyne, 2003
2,3,4,7,8-PeCDF	Chicken	Mortality, chick edema	Chronic	LOAEL	0.203	0.0001	-	-	-	0.0001	1.2	TEF from Van den Berg et al. 1998	Rocketdyne, 2003
2,3,7,8-TCDF	Chicken	Mortality, chick edema	Chronic	LOAEL	0.121	0.0001	-	-	-	0.0001	1.2	McKinney et al. 1976	U.S. Air Force, 2004
4,4'-DDD	Pelican	Reproductive effects	Chronic	EL	3.5	0.027	-	-	-	0.027	1.2	EFA West, 1998	EFA West, 1998
4,4'-DDE	Mallard	Reproductive effects	Chronic	EL	1	0.6	-	-	-	0.6	1.2	EFA West, 1998	EFA West, 1998
4,4'-DDT	Mallard	Reproductive effects	Chronic	EL	1	1.5	-	-	-	1.5	1.2	EFA West, 1998	EFA West, 1998
4-methylphenol	Red-winged Blackbird	Mortality	Acute	LD50	0.04	96	10	2	-	4.8	1.2	Schafer et al. 1983	Rocketdyne, 2003
Acenaphthylene	Red-Winged Blackbird	Mortality	Acute	LD50	0.04	101	10	2	-	5.05	1.2	Schafer et al. 1983 (Acenaphthene as surrogate)	Rocketdyne, 2003
Acetone	Japanese Quail	Survival / mortality	Subchronic	NOAEL	0.043	10483	10	2	1/5	2620.75	1.2	Hill and Camardese 1986	U.S. Air Force, 2004
alpha-Chlordane	Red-Winged Blackbird	Mortality	Subchronic	LOAEL	0.064	11	10	2	-	0.55	2.492	Stickel et al. 1983 (Chlordane)	U.S. Air Force, 2004
Anthracene	Red-winged Blackbird	Mortality	Acute	LD50	0.04	111	10	2	-	5.55	1.2	Schafer et al. 1983	Rocketdyne, 2003
Aroclor 1248	Chicken	Hatchability	Chronic	EL	0.1085	1.27	-	-	-	1.27	1.2	EFA West, 1998	EFA West, 1998
Aroclor 1254	Chicken	Hatchability	Chronic	EL	0.1085	1.27	-	-	-	1.27	1.2	EFA West, 1998	EFA West, 1998
Aroclor 1260	Chicken	Hatchability	Chronic	EL	0.1085	1.27	-	-	-	1.27	1.2	EFA West, 1998	EFA West, 1998
Dieldrin	Mallard	Some mortality	Subchronic	LOAEL	1	5	10	2	-	0.25	1.201	Hudson et al. 1984	U.S. Air Force, 2004
di-n-butyl phthalate	Ringed Dove	Reproduction	Chronic	LOAEL	0.155	1.1	-	-	-	1.1	1.2	Peakall et al. 1974	Rocketdyne, 2003
Endrin	Screech Owl	Reproduction	Chronic	LOAEL	0.181	0.1035	-	-	-	0.1035	1.25	Fleming et al. 1982	Rocketdyne, 2003
Endrin aldehyde	Screech Owl	Reproduction	Chronic	LOAEL	0.181	0.1035	-	-	-	0.1035	1.25	Fleming et al. 1982	Rocketdyne, 2003
Fluorene	Red-Winged Blackbird	Mortality	Acute	LD50	0.04	101	10	2		5.05	1.2	Schafer et al. 1983	Rocketdyne, 2003
gamma-Chlordane	Red-Winged Blackbird	Mortality	Subchronic	LOAEL	0.064	11	10	2	-	0.55	2.492	Stickel et al. 1983 (Chlordane)	U.S. Air Force, 2004
HpCDD (total)	Chicken	Mortality, chick edema	Chronic	LOAEL	0.203	0.1	-	-	-	0.1	1.2	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
HxCDD (Total)	Chicken	Mortality, chick edema	Chronic	LOAEL	0.203	0.001	-	-	-	0.001	1.2	TEF from Van den Berg et al. 1998	Rocketdyne, 2003
HxCDF (total)	Chicken	Mortality, chick edema	Chronic	LOAEL	0.203	0.001	-	-	-	0.001	1.2	TEF from Van den Berg et al. 1998	Rocketdyne, 2003
Methoxychlor	Japanese Quail	Mortality	Subchronic	NOAEL	0.043	1310.5	10	2	1/5	327.63	1.2	Hill et al, 1975	ECOTOX
OCDD	Chicken	Mortality, chick edema	Chronic	LOAEL	0.203	1	-	-	-	1	1.2	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
OCDF	Chicken	Mortality, chick edema	Chronic	LOAEL	0.203	1	-	-	-	1	1.2	TEF from Van den Berg et al. 1998 (2,3,7,8-TCDD)	Rocketdyne, 2003
PeCDF (Total)	Chicken	Mortality, chick edema	Chronic	LOAEL	0.203	0.0001	-	-	-	0.0001	1.2	TEF from Van den Berg et al. 1998	Rocketdyne, 2003
Phenanthrene	Red-Winged Blackbird	Mortality	Acute	LD50	0.04	113	10	2		5.65	1.2	Schafer et al. 1983	Rocketdyne, 2003
Perchlorate[b]	Bobwhite Quail	Developmental - femur length	Chronic	LOAEL	0.08	308	-	-	-	308	1.2	McNabb et al. 2004	-
Perchlorate[c]	Bobwhite Quail	Thyroid weight	Chronic	LOAEL	0.08	154	-	-	-	154	1.2	McNabb et al. 2004	-
TCDF (Total)	Chicken	Mortality, chick edema	Chronic	LOAEL	0.203	0.0001	-	-	-	0.0001	1.2	TEF from Van den Berg et al. 1998	Rocketdyne, 2003

	Primary Study Information:								Uncertainty Factors			
Chemical:	**Test Species**	**Endpoint**	**Chronic/ Subchronic**	**Effect level**	**Exposure Duration**	**Body Weight (kg)**	**Non-adjusted TRV (mg/m^3)**	**Dose - Time Adjustment (to 24 hrs/day, 7 days/week)**	**Non-sensitive to sensitive**	**Subchronic to Chronic UF**	**LOAEL to NOAEL UF**	**Adjusted NOAEL-Equivalent TRV (mg/m^3)**
1,1,1-Trichloroethane	Gerbil	neurological	Subchronic	NOAEL	24 hr day	0.1	76.4	-	-	2	-	38.2
1,1,2-Trichloroethane	Mouse	survival, LC50	Subchronic	LC50	6 hour	0.03	22.7	22.7*6hrs/24hrs = 5.675	-	100 *(LD $_{50}$ to NOAEL)*		0.05675
1,1-Dichloroethane	Cat	hepatic, renal, hematopoetic	Subchronic	NOAEL	6 hrs/day, 5 days/wk	2	404.8	404.8*6hrs/24hrs*5days/7days = 72.29	-	2		36.15
1,1-Dichloroethene	Guinea Pig	survival	Subchronic	LOAEL	24 hrs/day	0.5	6	-	***	-	10	0.6
1,1-Dichloropropene	Mouse	respiratory	Chronic	NOAEL	6 hrs/day, 5 days/wk	0.03	22.7	22.7*5 days/7 days*6 hrs/24 hrs = 4.05	-	-	-	4.05
1,2,3-Trichlorobenzene	Rat	hepatic	Subchronic	NOAEL	6 hrs/day; 7 days/wk	0.35	397	397*6 hrs/24 hours = 99.25	-	2	-	49.625
1,2,4-Trichlorobenzene	Rat	hepatic	Subchronic	NOAEL	6 hrs/day; 7 days/wk	0.35	397	397*6 hrs/24 hours = 99.25	-	2	-	49.625
1,2,4-Trimethylbenzene	Rat	behavior (rotorod performance, spontaneity)	Chronic	LOAEL	6 hrs/day, 5 days/wk	0.35	434	434*6 hrs/24 hrs*5 days/7 days = 77.5	-	-	5	15.5
1,2-Dichlorobenzene	Rat	hepatic	Subchronic	NOAEL	6 hrs/day; 7 days/wk	0.35	397	397*6 hrs/24 hours = 99.25	-	2	-	49.625
1,2-Dichloroethane	Rat	systemic	Chronic	NOAEL	7 hrs/day, 5 days/wk	0.35	202.4	202.4*7 hrs/24 hrs*5 days/7 days = 42.167	-	-	-	42.167
1,2-Dichloroethene	Rat	systemic	Subchronic	LOAEL	8 hrs/day; 5 days/wk	0.35	79.3	79.3*8 hrs/24 hrs*5 days/7 days = 18.88	-	-	10	1.89
1,2-Dichloropropane	Rat	respiratory	Subchronic	LOAEL	6 hrs/day; 5 d/wk	0.35	69	69*6 hrs/24 hrs*5days/7days = 12.3	-	-	10	1.23
1,2-Dichlorotetrafluoroethane (Fre	Rat	maternal wt. gain	Chronic	NOAEL	24hrs/day,	0.35	909	-	10	-	-	90.9
1,3,5-Trimethylbenzene	Rat	behavior (rotorod performance, spontaneity)	Chronic	LOAEL	6 hrs/day, 5 days/wk	0.35	434	434*6 hrs/24 hrs*5 days/7 days = 77.5	-	-	5	15.5
1,3-Dichlorobenzene	Rat	hepatic	Subchronic	NOAEL	6 hrs/day; 7 days/wk	0.35	397	397*6 hrs/24 hours = 99.25	-	2	-	49.625
1,4-Dichlorobenzene	Rat	hepatic	Subchronic	NOAEL	6 hrs/day; 7 days/wk	0.35	397	397*6 hrs/24 hours = 99.25	-	2	-	49.625
2-Butanone (MEK)	Mouse	development	Chronic	NOAEL	7 hrs/day	0.03	2978	2978*7 hrs/24 hrs = 868.58	-	-	-	868.58
2-Hexanone	Rat	neurological	Subchronic	NOAEL	8 hrs/day; 5 days/wk	0.35	20.5	20.5*8 hrs/24 hrs*5 days/7 days =4.88	-	2	-	2.44
2-Methylnaphthalene	Mouse	olfactory	Chronic	LOAEL	6 hrs/day; 5 days/wk	0.03	10.5	10.5*6 hrs/24 hrs*5 days/7 days = 1.875	-	-	5	0.375
Acetone	Rat	developmental	Chronic	NOAEL	6 hr/day; 7 days/wk	0.35	5220	5220*6 hrs/24 hrs = 1305	-	-	-	1305
Benzene	Mouse	systemic (decreased CFU-E lympocytes and	Subchronic	LOAEL	6 hrs/day, 5 days/wk	0.03	32	32*6 hrs/24 hrs*5 days/7 days = 5.714	-	-	10	0.5714
Carbon disulfide	Rat	cardio	Subchronic	NOAEL	8 hrs/day, 5 days/wk	0.35	2	2*8 hrs/24 hrs*5 days/7 days = 0.476	-	2	-	0.238
Carbon tetrachloride	Guinea Pig	survival	Subchronic	LOAEL	24 hrs/day	0.5	6.3	-	***	-	10	0.63
Chlorobenzene	Rat	hepatic, renal	Chronic	NOAEL	6 hr/day; 7 days/wk	0.35	230.2	230.2*6 hrs/24 hrs = 57.55	-	-	-	57.55
Chloroethane	Mouse	development	Chronic	NOAEL	6 hrs/day	0.03	3968.2	3968.2*6 hrs/24 hrs = 992.05	-	-	-	992.05
Chloroform	Mouse	renal	Subchronic	NOAEL	6 hrs/day; 7 days/wk	0.03	1.94	1.94*6 hrs/24 hrs = 0.485	-	2	-	0.243
Chloromethane	Mouse	neurological, hepatic	Chronic	LOAEL	6 hrs/day; 5 days/wk	0.03	20.7	20.7*6 hrs/24 hrs*5 days/7 days = 3.696	-	-	5	0.7392
cis-1,2-Dichloroethene	Rat	systemic	Subchronic	LOAEL	8 hrs/day; 5 days/wk	0.35	79.3	79.3*8 hrs/24 hrs*5 days/7 days = 18.88	-	-	10	1.888
Dichlorodifluoromethane (Freon 1:	Rat	maternal wt. gain	Chronic	NOAEL	24hrs/day,	0.35	909	-	10	-	-	90.9
Ethylbenzene	Rat	systemic (blood and renal effects)	Subchronic	LOAEL	6 hrs/day, 5 days/wk	0.35	1301	1301*6 hours/24 hrs*5 days/7 days = 232.32	-	-	10	23.232
Ethylene dibromide	Rat	respiratory	Subchronic	NOAEL	6 hrs/day	0.35	4.62	4.62*6 hrs/24 hrs = 1.155	-	2	-	0.5775
Fluorene	Hamster	tumors	Chronic	NOAEL	4.5 hrs/day; 7	0.125	0.9	0.9*4.5 hrs/24 hrs = 0.169	-	-	-	0.169
Freon 113	Rat	maternal wt. gain	Chronic	NOAEL	24hrs/day,	0.35	909	-	10	-	-	90.9
Isopropylbenzene (cumene)	Rat	systemic (blood and renal effects)	Subchronic	LOAEL	6 hrs/day, 5 days/wk	0.35	1301	1301*6 hours/24 hrs*5 days/7 days = 232.32	-	-	10	23.232
m,p-Xylenes	Rat	behavior (rotorod performance, spontaneity)	Chronic	LOAEL	6 hrs/day, 5 days/wk	0.35	434	434*6 hrs/24 hrs*5 days/7 days = 77.5	-	-	5	15.5
Methyl tert-butyl ether (MTBE)	Rat	hepatic, renal, development, endocrin	Chronic	NOAEL	6 hrs/day, 5 days/wk	0.35	1442.1	1442.1*6 hrs/24 hrs*5 days/7 days = 257.5	-	-	-	257.5
Methylene Chloride	Rat	hepatic, renal	Subchronic	NOAEL	24 hrs/day	0.35	1.74	-	-	2	-	0.87
Naphthalene	Mouse	olfactory	Chronic	LOAEL	6 hrs/day, 5 days/wk	0.03	10.5	10.5*6 hrs/24 hrs*5 days/7 days =1.875	-	-	5	0.375
n-butylbenzene	Rat	systemic (blood and renal effects)	Subchronic	LOAEL	6 hrs/day, 5 days/wk	0.35	1301	1301*6 hours/24 hrs*5 days/7 days = 232.32	-	-	10	23.232
n-Propylbenzene	Rat	systemic (blood and renal effects)	Subchronic	LOAEL	6 hrs/day, 5 days/wk	0.35	1301	1301*6 hours/24 hrs*5 days/7 days = 232.32	-	-	10	23.232
o-Xylene	Rat	behavior (rotorod performance, spontaneity)	Chronic	LOAEL	6 hrs/day, 5 days/wk	0.35	434	434*6 hrs/24 hrs*5 days/7 days = 77.5	-	-	5	15.5
p-cymene (p-isopropyltoluene)	Rat	behavior (rotorod performance, spontaneity)	Chronic	LOAEL	6 hrs/day, 5 days/wk	0.35	434	434*6 hrs/24 hrs*5 days/7 days = 77.5	-	-	5	15.5
Phenanthrene	Hamster	tumors	Chronic	NOAEL	4.5 hrs/day; 7	0.125	0.9	0.9*4.5 hrs/24 hrs = 0.169	-	-	-	0.169
sec-butylbenzene	Rat	systemic (blood and renal effects)	Subchronic	LOAEL	6 hrs/day, 5 days/wk	0.35	1301	1301*6 hours/24 hrs*5 days/7 days = 232.32	-	-	10	23.232
Styrene	Rat	neurological	Subchronic	NOAEL	24 hrs/day	0.35	76.7	-	-	2	-	38.35
t-butylbenzene	Rat	systemic (blood and renal effects)	Subchronic	LOAEL	6 hrs/day, 5 days/wk	0.35	1301	1301*6 hours/24 hrs*5 days/7 days = 232.32	-	-	10	23.232
Tetrachloroethene	Mouse	systemic (lung congestion, heptatocellular degeneration, necrosis)	Chronic	LOAEL	6 hrs/day, 5 days/wk	0.03	679	679*6 hrs/24 hrs*5 days/7 days = 121.25	-	-	5	24.25
Toluene	Rat	immune (increased susceptibility to infection)	Subchronic	LOAEL	3 hrs/day, 5 days/wk	0.35	9.4	9.4*3 hrs/24 hrs*5 days/7 days = 0.839	-	-	10	0.0839
trans-1,2-Dichloroethene	Rat	systemic	Subchronic	LOAEL	8 hrs/day; 5 days/wk	0.35	79.3	79.3*8 hrs/24 hrs*5 days/7 days = 18.88	-	-	10	1.888
Trichloroethene	Rat	behavior (decrased wakefulness, heart rate)	Subchronic	LOAEL	24 hrs/day; 5 days/wk	0.35	270	270*8 hrs/24 hrs*5 days/7 days =64.29	-	-	10	6.429
Trichlorofluoromethane (Freon 11)	Rat	maternal wt. gain	Chronic	NOAEL	24hrs/day,	0.35	909	-	10	-	-	90.9
Vinyl chloride	Rat	hepatic, testes	Subchronic	LOAEL	6 hrs/day; 6 days/wk	0.35	26	26*6 hrs/24 hrs*6 days/7 days = 5.57	-	-	10	0.557
Xylenes (total)	Rat	behavior (rotorod performance, spontaneity)	Chronic	LOAEL	6 hrs/day, 5 days/wk	0.35	434	434*6 hrs/24 hrs*5 days/7 days = 77.5	-	-	5	15.5

	Primary Study Information:								Uncertainty Factors			
Chemical:	**Test Species**	**Endpoint**	**Chronic/ Subchronic**	**Effect level**	**Exposure Duration**	**Body Weight (kg)**	**Non-adjusted TRV (mg/m^3)**	**Dose - Time Adjustment (to 24 hrs/day, 7 days/week)**	**Non-sensitive to sensitive**	**Subchronic to Chronic UF**	**LOAEL to NOAEL UF**	**Adjusted NOAEL-Equivalent TRV (mg/m^3)**

Chemical:	Sample & Arenal 1999 Mammalian Allometric Scaling Factor	Source	Source/TRV Provided by:
1,1,1-Trichloroethane	0.648	Rosengren et al. 1985	Recommended by HERD
1,1,2-Trichloroethane	0.94	Gradiski et al. 1978	Recommended by HERD
1,1-Dichloroethane	0.94	Hofmann et al. 1971	Recommended by HERD
1,1-Dichloroethene	1.539	Prendergast et al. 1967	Recommended by HERD
1,1-Dichloropropene	0.94	Lomax et al. 1989 (1,3-DCP)	Recommended by HERD
1,2,3-Trichlorobenzene	0.94	1,4-Dichlorobenzene as surrogate	Recommended by HERD
1,2,4-Trichlorobenzene	0.94	1,4-Dichlorobenzene as surrogate	Recommended by HERD
1,2,4-Trimethylbenzene	0.94	Tech Memo (Xylenes)	Tetra Tech, 2002
1,2-Dichlorobenzene	0.94	1,4-Dichlorobenzene as surrogate	Recommended by HERD
1,2-Dichloroethane	0.835	Cheever et al. 1990	Recommended by HERD
1,2-Dichloroethene	0.94	Freundt et al. 1977	Recommended by HERD
1,2-Dichloropropane	0.94	Nitschke et al. 1988	Recommended by HERD
1,2-Dichlorotetrafluoroethane (Freon	0.94	Palmer et al. 1978 (Freon 22)	Recommended by HERD
1,3,5-Trimethylbenzene	0.94	Tech Memo (Xylenes)	Tetra Tech, 2002
1,3-Dichlorobenzene	0.94	1,4-Dichlorobenzene as surrogate	Recommended by HERD
1,4-Dichlorobenzene	0.94	Tyl and Neeper-Bradley, 1989	Recommended by HERD
2-Butanone (MEK)	0.94	Mast et al. 1989	Recommended by HERD
2-Hexanone	0.94	Duckett et al. 1979	Recommended by HERD
2-Methylnaphthalene	0.94	NTP 1992 (Naphthalene)	Recommended by HERD
Acetone	1.128	NTP 1998	U.S. Air Force, 2004
Benzene	0.818	Tech Memo	Tetra Tech, 2002
Carbon disulfide	0.94	Antov et al. 1985	Recommended by HERD
Carbon tetrachloride	0.703	Prendergast et al. 1967	Recommended by HERD
Chlorobenzene	0.94	Nair et al. 1987	Recommended by HERD
Chloroethane	0.94	Scortichini et al. 1986	Recommended by HERD
Chloroform	1.192	Larson et al. 1996	Recommended by HERD
Chloromethane	0.94	CIIT 1981, McKenna et al. 1981	Recommended by HERD
cis-1,2-Dichloroethene	0.94	Freundt et al. 1977 (1,2-DCE)	Recommended by HERD
Dichlorodifluoromethane (Freon 12)	0.94	Palmer et al. 1978 (Freon 22)	Recommended by HERD
Ethylbenzene	0.94	Tech Memo	Tetra Tech, 2002
Ethylene dibromide	0.94	Nitschke et al. 1981; Reznik et al. 1980	Recommended by HERD
Fluorene	0.94	Thyssen et al. 1981 (BaP)	Recommended by HERD
Freon 113	0.94	Palmer et al. 1978 (Freon 22)	Recommended by HERD
Isopropylbenzene (cumene)	0.94	Tech Memo (Ethylbenzene)	Tetra Tech, 2002
m,p-Xylenes	0.94	Tech Memo (Xylenes)	Tetra Tech, 2002
Methyl tert-butyl ether (MTBE)	0.94	Chun et al. 1992	Recommended by HERD
Methylene Chloride	0.94	Haun et al. 1972	Recommended by HERD
Naphthalene	0.94	NTP 1992	Recommended by HERD
n-butylbenzene	0.94	Tech Memo (Ethylbenzene)	Tetra Tech, 2002
n-Propylbenzene	0.94	Tech Memo (Ethylbenzene)	Tetra Tech, 2002
o-Xylene	0.94	Tech Memo (Xylenes)	Tetra Tech, 2002
p-cymene (p-isopropyltoluene)	0.94	Tech Memo (Xylenes)	Tetra Tech, 2002
Phenanthrene	0.94	Thyssen et al. 1981 (BaP)	Recommended by HERD
sec-butylbenzene	0.94	Tech Memo (Ethylbenzene)	Tetra Tech, 2002
Styrene	0.94	Rosengren and Haglid 1989	Recommended by HERD
t-butylbenzene	0.94	Tech Memo (Ethylbenzene)	Tetra Tech, 2002
Tetrachloroethene	1.05	Tech Memo	Tetra Tech, 2002
Toluene	0.94	Tech Memo	Tetra Tech, 2002
trans-1,2-Dichloroethene	0.94	Freundt et al. 1977 (1,2-DCE)	Recommended by HERD
Trichloroethene	1.111	Tech Memo	Tetra Tech, 2002
Trichlorofluoromethane (Freon 11)	0.94	Palmer et al. 1978 (Freon 22)	Recommended by HERD
Vinyl chloride	0.94	Bi et al. 1985	Recommended by HERD
Xylenes (total)	0.94	Tech memo	Tetra Tech, 2002

Appendix E-8
Mammal Inhalation TRVs
Georgia-Pacific Corporation
Fort Bragg, California

Chemical:	Sample & Arenal 1999 Mammalian Allometric Scaling Factor	Source	Source/TRV Provided by:

Notes:

a - If the body weight of the receptor differs from the body weight of the test animal, an allometric scaling factor is applied: $TRV_{adjusted} = TRV_{unadjusted}$ *

*** - Determined by DTSC to be the lowest dose at which an adverse effect occurred, therefore no non-sensitive to sensitive endpoint needs to be applied.